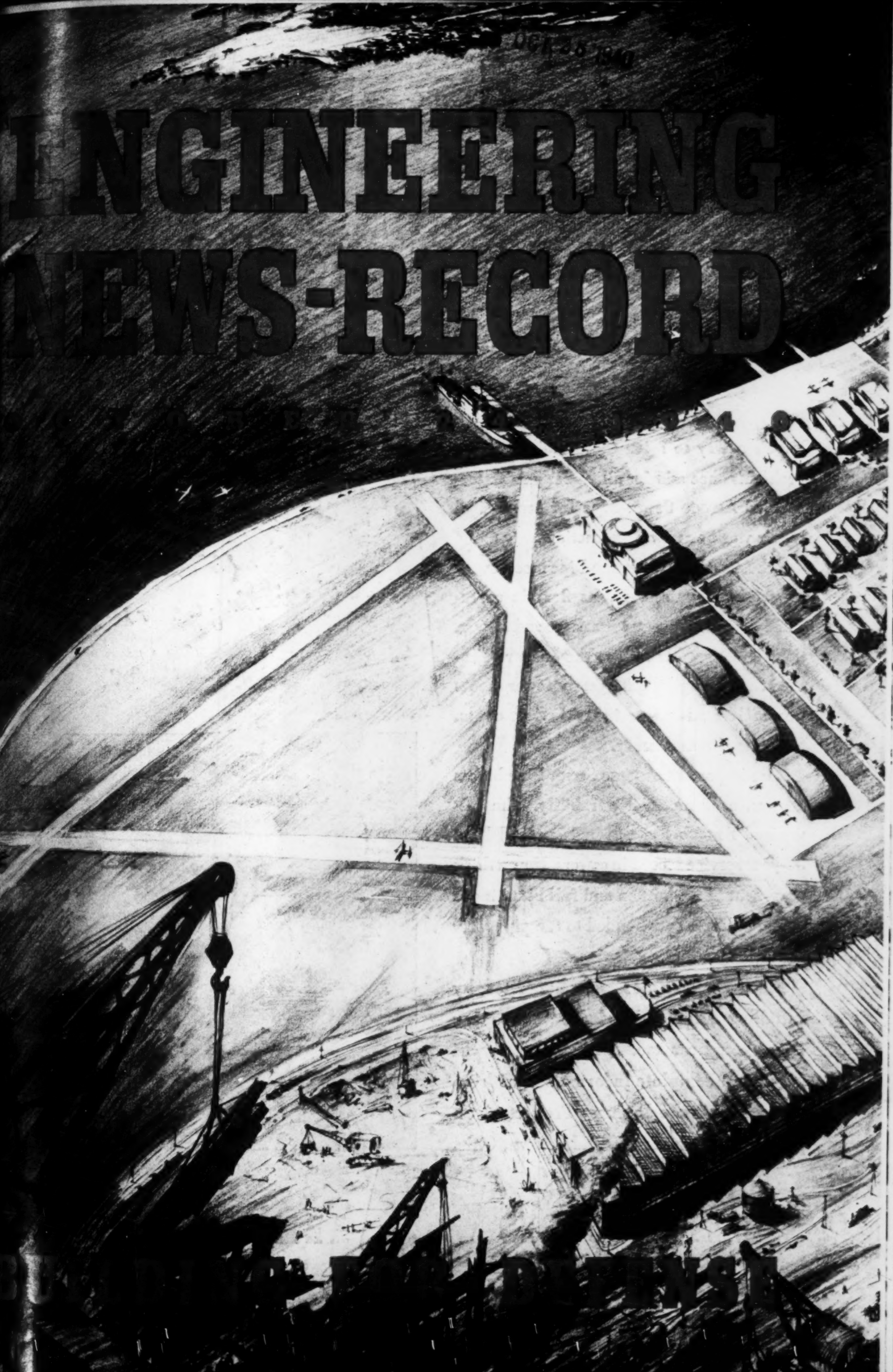
OCT 28 1940

ENGINEERING NEWS-RECORD

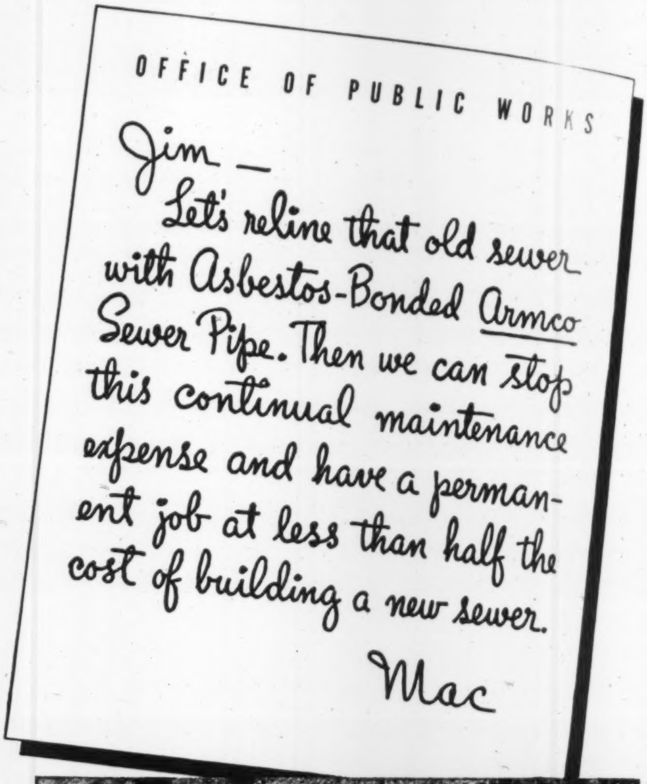
OCTOBER 24, 1940



BUILDING FOR DEFENSE

You Can Write the Order

THAT WILL END SEWER TROUBLES!



OFFICE OF PUBLIC WORKS

Jim —

Let's reline that old sewer with Asbestos-Bonded Armco Sewer Pipe. Then we can stop this continual maintenance expense and have a permanent job at less than half the cost of building a new sewer.

Mac

Here's a way to solve those difficult sewer problems once and for all. Specify Asbestos-Bonded ARMCO Sewer Pipe for economical repair work or new construction.

Asbestos-Bonded ARMCO Pipe meets every sewer line requirement. Its flexible corrugated design eliminates breakage and strong, tight joints greatly reduce the danger of infiltration. Long lengths mean fewer joints per mile and lower installation costs. Cradling is unnecessary.

Also important, ARMCO Sewer Pipe brings assurance of material durability. The galvanized ARMCO Ingot Iron is proved by a 33-year service record in sewers. Now a thick pavement in the bottom and full bituminous coating inseparably bonded to the pipe offer much longer service.

Many major cities have benefited by installing Asbestos-Bonded ARMCO Sewer Pipe. Yours can too. A request to us will bring you complete information with no obligation. Armco Drainage Products Association, 5010 Curtis St., Middletown, Ohio.

A disintegrating brick sewer is permanently repaired with Asbestos-Bonded ARMCO Sewer Pipe. Approximately 600 feet of 72-inch ARMCO Pipe was threaded into the sewer without interrupting street traffic and at less than half the cost of rebuilding.

ASBESTOS-BONDED ARMCO SEWER PIPE

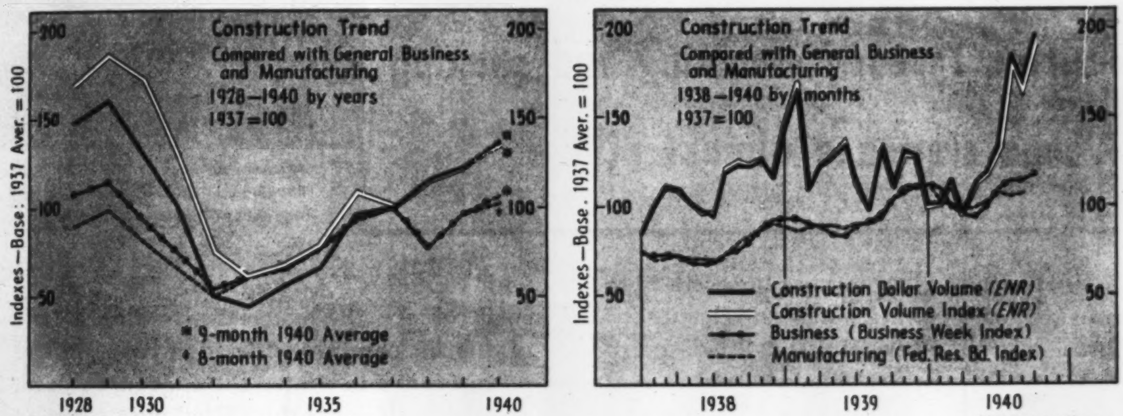
ORIGINATED AND DEVELOPED BY ARMCO ENGINEERS

CONSTRUCTION TRENDS

Notes on significant movements in the construction industry

Construction volume soars with defense speed-up

National defense spending for military and naval projects has brought engineering construction for 42 weeks of 1940 to a point 19 per cent above the volume for the corresponding 1939 period. At the end of the first half of the year, before the defense program began in earnest, the total lagged 11 per cent behind last year, but in the brief space of 16 weeks, more than one and one-half billion dollars worth of construction has been awarded to bring the volume to its present 19 per cent increase over last year.



DEFENSE STRENGTHENS CONSTRUCTION'S ECONOMIC POSITION

ENR Business News

The *ENR* Index of Construction Dollar Volume (1937 = 100) illustrates the steep rise from 135 in June to 196 in September. It is still shooting up if the first three weeks of October are any criterion. The third week of the month saw $239,000,000 in engineering contracts awarded, the peak for any week in history, and this, in combination with two better-than-average weeks at the opening of October, indicates a preliminary index figure of around 250.

Construction costs from July to October have increased slightly more than 1 per cent. The *ENR* Construction Volume Index which takes these cost changes into account, thus measuring actual physical volume, accordingly has not climbed quite as high as the Dollar Volume Index. The June value was 132 and the September figure, 190. Both the Dollar and Physical Volume Indexes, though, are well above their respective 1929 averages of 160 and 185.

The leading part played by construction in the nation's economy is evident in comparisons made with general business and manufacturing. The present high construction activity represents the first stages of the national defense program.

During the period from June through September general business as reflected by the Business Week Index (1937 = 100) rose from 110 to 118. The Federal Reserve Board Index of Manufacturing for August, 107, has dropped 1 point from the June figure. Both of these indexes currently top their respective 1929 averages, but their present rates of increase are not nearly so precipitous as that of construction, spurred on by defense building. Construction, as a matter of fact, has again anticipated the rise in business and manufacturing, just as in the 1938 PWA program.

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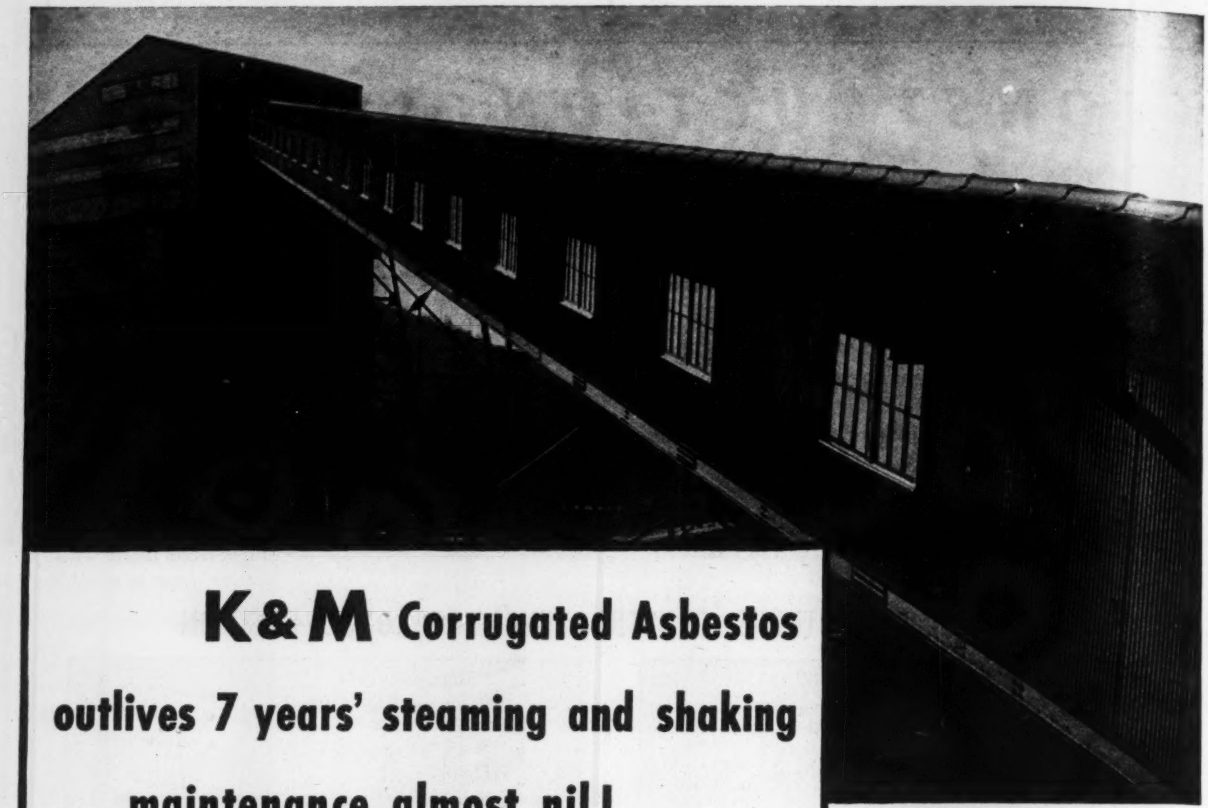

K&M Corrugated Asbestos outlives 7 years' steaming and shaking . . . maintenance almost nil!

Breaker building of the Philadelphia & Reading Coal & Iron Company, with roof and sidewalls of "Century" Corrugated Asbestos.

One of the largest coal breakers in the world is this St. Nicholas District Central Breaker of the Philadelphia & Reading Coal & Iron Company. Its sidewalls and roof are Keasbey & Mattison "Century" Corrugated Asbestos. In the seven years since it was built, this tremendous expanse of "Century" Corrugated has resisted, without cracking, the extreme vibration present in all coal breakers. It has never needed a drop of paint for protection against the weather, and never will.

The breaker is only one of many buildings in this great plant that are protected with "Century" Corrugated. The thawing shed subjects the material to a different set of difficult conditions. Loaded coal cars are pushed into it in winter, the doors are closed, and the building is then filled with steam to thaw the tight-frozen coal. Yet, here, as throughout the entire plant, the maintenance cost of the "Century" Corrugated has been practically nil.

"Century" Corrugated is fire- and weather-resisting, rust-proof and rot-proof. It doesn't require painting. Why not let it start cutting building maintenance for you, too? Write Dept. 05 for complete catalogue information.

K&M "Century" CORRUGATED ASBESTOS

KEASBEY & MATTISON

COMPANY, AMBLER, PENNSYLVANIA

K&M best in asbestos

ENGINEERING NEWS-RECORD

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F. E. SCHMITT *and* WALDO G. BOWMAN, *Editors* • ALBERT E. PAXTON, *Manager*

Vol. 125 OCTOBER 24, 1940 No. 17

THIS WEEK

• The construction industry in America has been called to arms to meet the demands for an adequate national defense. As in 1917 the job is on an emergency basis. The work at hand calls for the utmost in cooperation and coordination of men and minds if the vast program is to be completed in the limited time which the emergency demands. As a service to the industry this issue of *Engineering News-Record* on *Building for Defense* has been prepared. A brief but composite resume of accomplishments to date is presented, together with a mass of factual information.

THINGS TO COME

• Construction of the great vehicular tunnel under the River Maas at Rotterdam, started prior to the invasion of the Low Countries, offers an exceptional example of engineering ingenuity. Unusually exact methods were developed for aligning, leveling and coupling the shore-built units that were sunk to river bottom for the under water part of the tunnel. In the Nov. 7 issue the method used in carrying out this tunnel construction will be published.

• How the cost of large culverts under high fills can be reduced by use of specially designed variable-gage corrugated metal pipe will be featured in the Nov. 7 issue.

• At a cost of only 4c. per sq. yd., a 25-mile four-lane concrete highway over a pumping subgrade has been satisfactorily saved from disintegration through a systematic program of forcing the water out with compressed air, filling the subgrade voids and lifting the slabs back to position with a cement-oil-earth slurry forced through drill holes by a mud jack. The procedure will be described in an early issue.

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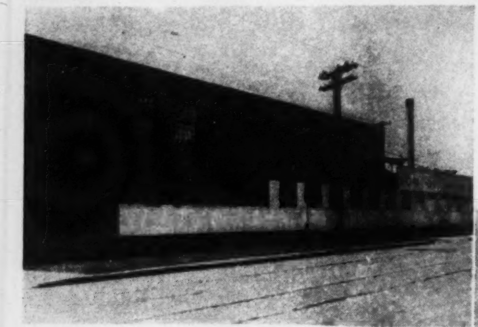
From old brick to . . .

MODERN CONCRETE

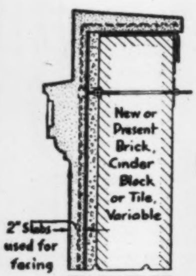
with ARCHITECTURAL CONCRETE SLABS!

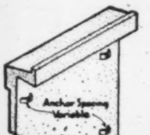


CORPORATION OF AMERICA

▲ **OLD BRICK WALL** of the Wire Rope Corp. of America plant in New Haven, Conn., begins to disappear under new modern facing of Architectural Concrete Slabs. The slabs, *only two inches thick*, made it unnecessary to tear down the old wall.

EXTERIOR TRANSFORMATION COMPLETE. Architectural Concrete Slabs were easily and quickly lifted into position. Bolts through old masonry gave permanent anchorage. Appearance of whole building greatly improved. Architect, Leo F. Caproni, New Haven. Slabs made with crushed quartz and Atlas White portland cement by The Dextone Company, New Haven, Conn. ➤





LEFT: This detail shows how parapet and coping are cast monolithically with the slab and how slabs are anchored to masonry walls by tie rods.

RIGHT: Typical spandrel unit with returns cast monolithically with the slab. Note anchors fastened to embedded reinforcing mesh for bolting to tie rods.

MANY modernization jobs are today simpler, faster and less expensive.

A new building material—Architectural Concrete Slabs—gives to old walls a modern facing that combines structural strength with decoration. The Wire Rope Corporation transformation shown here, and similar jobs for Consolidated Edison of N.Y., Sears-Roebuck, Woolworth—for chain stores, factories, theatres, office buildings—prove the practicability of these thin slabs for almost any modernization job.

What are Architectural Concrete Slabs? Factory-made units of reinforced concrete made with selected aggregates exposed in a matrix of Atlas White portland cement. Slabs are precast in sizes up to 100 square feet or more, and 20 feet or more in length, yet are only 2 inches thick. They are made in many shapes, including curves, angles, channels; monolithic units that are wrapped around corners, and spandrels that include window head and window sill. They may be plain or patterned in a wide variety of colors and textures.

These slabs bring new economies to modernization. They are quickly and economically anchored in place to old masonry walls. Their large size and varied shapes reduce flashing, danger of leakage, and erection costs. They improve property appearance and values.

It will pay to know more about these thin Architectural Concrete Slabs for interiors and exteriors of new and old buildings, and for bridges and other engineering structures. For information on remarkable structural and decorative uses, on wide adaptability and unusual economies of these slabs made with Atlas White cement—see SWEET'S CATALOG, Section 4, or write to Universal Atlas Cement Co. (United States Steel Corp. Subsidiary), Dept. A4, Chrysler Building, N. Y. C.

NR-ACS-8

ARCHITECTURAL CONCRETE SLABS

MADE WITH ATLAS WHITE CEMENT

The Week In Engineering and Construction

ENGINEERING NEWS-RECORD • OCTOBER 24, 1940

City work claims attention of A. S. C. E. at Cincinnati

Fall meeting papers concentrate on the civil engineer's services to the community but highway and power problems are also discussed

Municipal problems of all kinds comprised the theme of the general sessions of the American Society of Civil Engineers fall meeting, Oct. 16-18, in Cincinnati. Five technical divisions—power, city planning and surveying and mapping (a joint meeting), sanitary engineering and highways—held the attention of the 520 registrants on the second day. Unusual was a carry-over of the general sessions to the third day, prior to an inspection trip to Middletown to the plants of the American Rolling Mill Co. Equally unusual was the large group of educational exhibits by the city, and by the Army engineers, the latter relating to Ohio River structures.

At the meeting of the board of direction prior to the convention, Frederick Hall Fowler, consulting engineer, San Francisco, was chosen as the official nominee for president. Other nominees were as follows: Vice presidents, C. H. Stevens, Philadelphia; and Charles B. Burdick, Chicago; for directors, John W. Cowper, Buffalo; R. B. Wiley, Lafayette, Ind.; John W. Cunningham, Portland, Ore.; G. J. Requardt, Baltimore; George B. Massey; Chicago, and E. E. Howard, Kansas City.

The board voted to exempt "selectees" of the draft and enlisted men from dues during the prorated period of their service. The ruling, however, does not include commissioned officers.

A committee on the allocation of costs of multi-purpose water projects was authorized under sponsorship of the revamped engineering economics division, the personnel to be drawn from the divisions interested. E. B. Black heads the economics division.

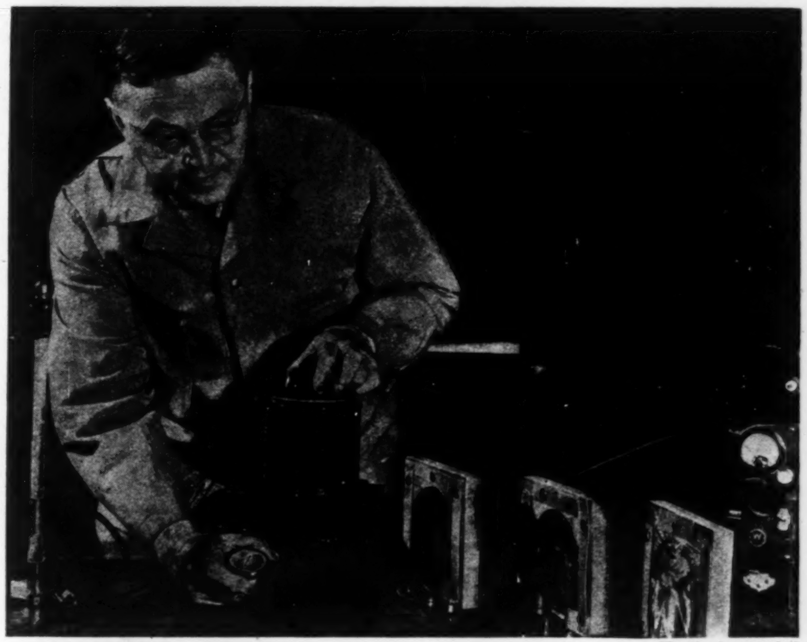
E. P. Goodrich, of the board committee on civilian protection, urged the highway engineers attending the highway division meeting to make plans now for removing refugees at the same time main roads might be in use for military purposes. Plans should be studied, he said, for handling of civilian traffic on secondary roads to relieve the congestion experienced in France just before the fall of Paris. Alternate and bypass routes should be mapped and marked, Goodrich declared, so that the civilian population can become familiar with them.

Washington report

Reporting on national defense activities, Walter E. Jessup, field secretary, who was detailed by the board in July to take up residence in Washington, indicated results of his work in contacting various federal agencies as follows:

The census questionnaire, initiated by the National Committee on Construction

(Continued on page 29)



Westinghouse photo

Micro blitzkrieg goes to work on bacteria

Sanitary engineers may soon have another weapon in their war against bacteria, based on new knowledge concerning the application of ultra-violet radiations as a sterilizing agent. The drama of invisible light pitted against pathogenic organisms was unfolded by Harvey C. Rentschler, director of research for the Westinghouse Lamp Division, at a conference in Bloomfield, N. J. last week attended by college educators and a technical press group.

The "death ray" produced by the tubular lamp shown at the left of Rentschler in the above photo hurls a barrage of ultra-violet radiations which kills instantly all micro-organisms in its path. Possible fields of new exploration include uses in water and sewage sterilization.

In connection with ultra-violet radiation studies it is to be recalled that R. F. Goudey, sanitary engineer, bureau of waterworks and supply, Los Angeles, Cal., has developed new methods of alga control resulting in big savings on chemical costs (ENR Apr. 11, 1940, p. 525).

Prefabricated housing seen as aid in meeting defense needs

Demountability considered primary value as Federal Works Agency technicians study possibilities

Prefabrication is not being used in any of the defense housing projects so far announced, but Federal Works Agency technicians are giving a great deal of consideration to prefabrication possibilities. It is pretty well established that part of the program will involve this type of construction.

Primary value of prefabrication to the present program is the possibility of demountability. In fact the distinction between temporary and permanent construction is likely in practice to mean prefabricated or conventional construction.

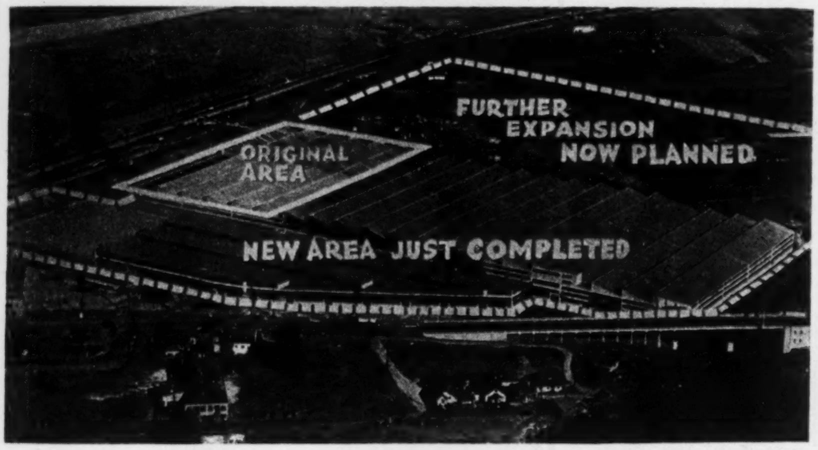
Where a continuing need for housing is foreseen, standard on-site construction will be used. Where, however, the need is thought likely to disappear with the emergency, a demountable prefabricated type will probably be used which can be moved to some other site where there is need for it.

So far the government is making no independent studies of prefabricated construction. Representatives of the various firms in the field are being interviewed, and one or more existing commercial types will doubtless be chosen. In this work FWA has the aid of detailed technical studies of various types of prefabricated panel which the Bureau of Standards has been making for several years.

CIO approves prefabrication

In view of past opposition on the part of organized labor to prefabrication, some importance is attached to a memorandum being circulated among officials by the CIO's housing committee. The memorandum is a complete endorsement of prefabrication in the interests of speed, avoidance of labor concentration, and perhaps of economy. The CIO urges immediate purchase of house components without waiting for individual projects to be worked out.

CIO endorsement of prefabrication is, of course, not unexpected. Transfer of building operations from the field to the factory will tend to strengthen the CIO as against the AFL. Moreover, it is understood that CIO's Construction Workers Organizing Committee has arranged informally with several of the firms making prefabricated houses to use CIO labor if the plan goes through.



Boeing Aircraft photo

Boeing to add 1,068,000 sq.ft. to Seattle plant

Although the floor area of Boeing Aircraft Co.'s plant No. 2 at Seattle was increased from 166,000 sq.ft. four months ago to 832,000 sq.ft. by an addition just now being completed, (see page 72), plans were announced this week to increase the plant still further by a 1,068,000-sq.ft. expansion. When the new work is complete, a total of 1,832,000 sq.ft. will be interconnected under one roof in a building 1,240 x 1,000 ft. The addition is to increase the production rate of large bombing planes for the national defense program. The Austin Company, building contractors of Cleveland, Ohio, will be in charge of engineering and construction.

Boeing has also announced that it will increase from 293,000 sq. ft. to 735,000 sq. ft. the size of the Wichita, Kansas plant of its subsidiary, the Stearman Aircraft Division.

The entire expansion program is scheduled for completion in not more than 140 days. When complete, Boeing's total plant facilities will be 3,235,000 sq.ft. or nearly five times that of a year ago.

New St. Lawrence studies authorized by President

The sum of $1,000,000 from the special defense fund has been allocated to the cost of new studies of power sites in the International Rapids section of the St. Lawrence River, according to special message sent to Congress by President Roosevelt on Oct. 17. The President advised Congress that surveys made by the Federal Power Commission and the National Power Policy Committee had convinced him that development of that section of the river should be undertaken at the earliest possible date "as part of adequate provision to meet continuing power requirements of the defense program." The President stated further that "if the potential power of the International Rapids is to be available to carry the peak load of 1945, preliminary investigations, particularly engineering surveys of the site, including core borings, test pits, soil analyses, etc. must be undertaken immediately."

The Corps of Engineers, U. S. Army, has been directed to start the studies immediately. A committee of four to advise the President in planning the work has been appointed. It consists of Leland Olds, chairman, Federal Power Commission; A. A. Berle, Assistant Secretary of State; Brig. Gen. Thomas M. Robins, Assistant Chief of Engineers; and Gerald V. Cruise of the New York State Power Authority.

What new field studies are required is not stated in the President's message. Over the past two decades several elaborate studies of the physical conditions at all possible dam sites have been made by joint engineering boards and other public bodies with the result that records of over 1,000 borings now are available.

• • •

Ruling on engineering work attacked and defended

The new definition of professional work that the Wage and Hour Division of the U. S. Department of Labor proposes to put into effect on Oct. 24 (*ENR*, Oct. 17, p. 504) has been attacked by the Federation of Architects, Engineers, Chemists and Technicians as "arbitrary, one-sided, and maliciously perpetrated." The federation has appealed to the President, to Secretary Frances Perkins and to Administrator Philip B. Fleming to have the new ruling set aside.

The new ruling has been endorsed by the directors of the Metropolitan Section, American Society of Civil Engineers, as preserving for the low-paid engineering employees the protection of the Wage-Hour Act against exploitation while at the same time freeing the higher-paid men, whose work is largely professional, from the restrictions of the act.

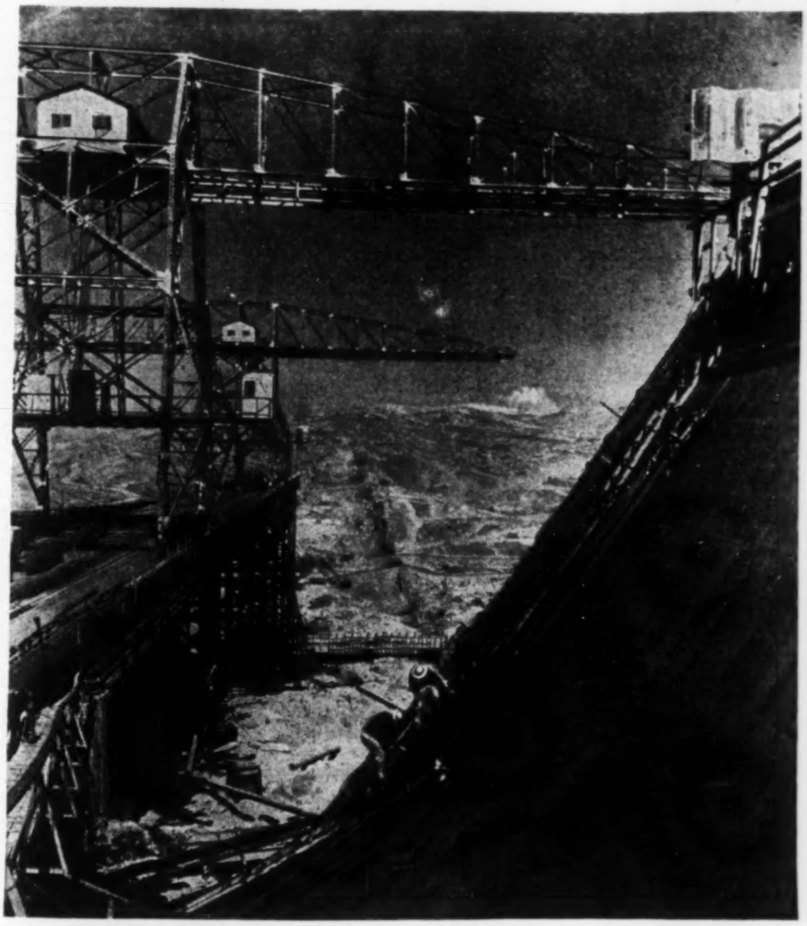
Steel fabricating capacity adequate for any needs

Throughout the sessions of the annual meeting of the American Institute of Steel Construction at White Sulphur Springs, W. Va., Oct. 15-18, there were repeated references to the role of the structural steel fabricating industry in national defense, and unanimous opinion that no new facilities are needed to care for any possible demands. Clyde C. Conley, president, pointed out that when the speed-up in activity began in July the industry was operating at only about 25 per cent capacity. Operations have been stepped up materially since then, but Conley said there is "no danger of bottlenecks and no need for priorities".

In the months from June to September, according to T. H. Hendrix, director of statistics, national defense orders totaled 198,000 tons. Some 56,000 tons of this were booked in July, the largest month save two since 1931; the total July bookings were 189,870 tons. During the first 8 months of 1940 bookings totalled 919,000 tons, which is slightly above the comparable period in 1939. Hendrix pointed out that orders for 50 tons or under account for 12 per cent of the industry's business; of 50 to 500 tons for 35 per cent; of 500 to 1,000 tons, 14 per cent; of 1,000 to 10,000 tons, 33 per cent; and over 10,000 tons, 6 per cent.

Among the speakers at the convention was L. W. Moffett, Washington correspondent of *The Iron Age*, who suggested that the time was propitious for the fabricating companies to take back from the steel mills some of the preliminary finishing operations, principally cutting to length and drilling, that had been relinquished to the mills during the depression. The rolling mills are hard pressed to meet deliveries, and should welcome giving up these operations at the present time. The possibilities for large use of steel in the developing market for parking garages were outlined by C. T. McGavin, of the Yale University Bureau for Traffic Research.

In his report, F. H. Frankland, chief engineer, stated that increased activity in the New York area had required adding a new district engineer, T. R. Higgins, chief engineer of the former New England Structural Co. Frankland stated that during the past year A.I.S.C.-sponsored research was carried out at Lehigh University on web crippling, short columns and continuity in riveted building frames; at Columbia University on comparisons of stress distribution in riveted plate girder splices; and at the National Bureau of Standards on stress distribution in and strength of perforated cover plates for compression members. The institute has been invited by the experimental laboratory of the U. S. Navy to sponsor an extension of its rigid frame investigations that were carried out at the Bureau of Standards and at Lehigh. The A.I.S.C. would design and furnish the test specimens and the Navy the equipment and staff to carry out the tests.



World's fourth largest concrete dam takes shape

The rapid advancement of the Friant Dam concrete work since it was begun on July 29 (ENR Aug. 8, 1940, p. 187) is illustrated by the above view, which is looking across the dam site from the Fresno County abutment where the first concrete was placed.

The Friant project, which is being built on the San Joaquin River in California to provide irrigation for five California counties, will require a total of 2,200,000 cu. yd. of concrete. Of the concrete gravity type 3,340 ft. long and 320 ft. high, the dam will be exceeded in the masonry class by only Boulder, Grand Coulee and Shasta dams. The 520,000 acre-ft. reservoir to be created will supply 70,000 acre-ft. for flood control and 350,000 acre-ft. for irrigation. The work, part of the Central Valley project, is estimated to cost over $16,000,000.

Besides placing the concrete the Friant work includes 770,000 cu. yd. of excavation, stripping 600,000 cu. yd. from gravel deposits, and handling 3,200,000 tons of aggregate. Griffith Co. and Bent. Co. are the general contractors.

• • •

Court upholds action on San Jacinto tunnel suit

Acting on an appeal brought by the Milwaukee contracting firm of Wenzel & Henoch of its suit against the Metropolitan Water District of Southern California the Ninth Circuit Court of Appeals upheld the action of the district in suspending in 1935 the firm's contract for the 13-mi. San Jacinto tunnel. The construction company had claimed that the ouster action by the district was void and erroneous and had asked damages in excess of five million dollars.

The general counsel for the water district stated that the firm had unreasonably and unnecessarily delayed construction of the tunnel, which is one of the vital links in the 192-mi. Colorado River aqueduct. The counsel further stated that the district acted in accordance with its contract when it took possession of the tunnel construction work early in 1935 (*ENR* Jan. 31, 1935, p. 178) and successfully completed the work on a force account basis.

U.S.B.R. engineer advances

Appointment of Walker R. Young as assistant chief engineer of the Bureau of Reclamation was announced by Secretary of Interior Ickes Oct. 15. Young, now supervising engineer of the Central Valley project in California, will have his headquarters in Denver.

Following graduation from the University of Idaho, with a Bachelor of Science degree in engineering in 1908, Young worked with the Great Northern Ry. and other private concerns until 1911, when he was made assistant engineer in the Bureau of Reclamation. One of his first tasks with that organization was to participate in the design of Arrowrock Dam in Idaho.

In 1916 he was made head of the bureau's mechanical and dam division of the designing department in the chief engineer's office in Denver, and in 1921 was placed in charge of field investigation leading to the plans adopted for the development of the Colorado River. He formulated the original designs and estimates for Boulder Dam.

Young, in 1924 was detailed to an investigation of the salt water incursion from Sacramento Bay into the Sacramento and San Joaquin Rivers; two years later he was appointed construction engineer of the Kittitas Division of the Yakima reclamation project in Washington. Leaving this in 1931 to be construction engineer in charge of the building of Boulder Dam, he saw the job through and in 1935 was placed in charge of the Central Valley project in California.

Oklahoma road program approved by PRA

A $5,057,018 federal aid highway program for the state of Oklahoma for 1941 has been approved by the Public Roads Administration. A similar program was rejected several weeks ago (*ENR* Sept. 5, 1940, p. 307) with the charge that little, if any, attention had been paid to defense and traffic flow needs in preparing the construction program for the current fiscal year.

JOBS OF THE WEEK

TRACK RELOCATION, Royalston, Mass.

T. Stuart & Son Co., Watertown, Mass., was awarded a contract by Boston & Maine R.R., W. F. Cummings, chief engineer, Boston, Mass., for relocating 3 mi. of track that will be flooded by construction of Birch Hill flood-control dam. Construction of two bridges will also be necessary. Estimated cost of the work is $900,000.

EARTH DAM, Canton, Okla.

T. L. James & Co., Inc. and Guilliams Bros., Ruston, La., were awarded a contract for a portion of the earth dam, 4 earth dikes, rough excavation for spillway, field offices, car shed, and inspectors quarters at Canton Dam, which is being built by the U. S. Engineers at an estimated cost of $1,439,000. The dam site is on the North Canadian River about 75 miles northwest of Oklahoma City.

SMOKELESS POWDER PLANT, Charlestown, Ind.

E. I. duPont de Nemours & Co., Wilmington, Del., received a $25,000,000 contract from the War Department for constructing and operating a plant for manufacture of smokeless powder. This is in addition to the $25,000,000 plant already underway at Charlestown.

AIRPLANE FACTORY, Seattle, Wash.

Austin Company, Cleveland, O., was awarded a contract by the Boeing Airplane Co., Seattle, for designing and constructing an enlargement of plant No. 2, a 4-story engineering and production building and a 3-story office building adjoining the main plant. Estimated cost of the works, including equipment, is $7,500,000.

ARMY CONCENTRATION CENTER, Leon, Ia.

C. F. Lytle Co., Klinger Construction Co., and Hubert Everist Co., all of Sioux City, and Arthur Neumann Co., Des Moines, were awarded a joint contract for the army concentration center. The work is estimated to cost $9,000,000.

TEMPORARY HOUSING, Fort Devens, Mass.

Coleman Brothers Corp., Boston, Mass. and John Bowen Co., Inc., Boston, Mass. will construct the temporary housing, storehouse and mess halls for the Constructing Quartermaster, Fort Devens. Estimated cost of the work, which is being done on a cost-plus-fixed-fee basis, is $8,256,000. William S. Lozier, Inc., Rochester, N. Y., is engineer and architect for the project.

TEMPORARY BARRACKS, Pine Camp, N. Y.

John W. Cowper, Inc., Buffalo, N. Y., and Senior & Palmer, Inc., New York, were awarded a $5,823,675 contract on a cost-plus-fixed-fee basis for temporary barracks at Pine Camp. William S. Lozier, Inc., Rochester, has the contract for the engineering and architectural services.

HOUSING UNITS, San Diego, Calif.

William Simpson Construction Co., Los Angeles, Calif., was awarded a Navy Department contract for constructing the housing units and accessories in the San Diego area, 1,200 dwellings at the Destroyer base, and 600 dwellings at the Marine Corps base. The work, being done on cost-plus-fixed-fee basis, is estimated to cost $3,800,000.

BARRACKS, Parris Island, S. C.

Charles W. Angle, Inc., and Potter & Shackleford, Inc., Greensboro, N. C. will build additional facilities, on a cost-plus-fixed-fee basis, at Marine Barracks. Work is estimated to cost $3,069,000.

HOUSING UNITS, Norfolk, Va.

Byrne Organization, Dallas, Tex., was awarded a $2,284,000 contract by the Navy Department for the housing units and necessary accessories at the Naval Operating Base, Norfolk, Va. Doyle & Russell, Richmond, Va., got a $856,000 contract for the storage facilities. Both contracts were awarded on a cost-plus-fixed-fee basis.

HOUSING UNITS, Long Beach, Calif.

McNeil Construction Co., Los Angeles, Calif., will build under terms of a $1,263,000 contract with the Navy Department the housing units and accessories.

HOUSING, Rock Island, Ill.

Lovering Construction Co., St. Paul, Minn., received a $1,044,420 contract for constructing housing for workers at Rock Island Arsenal. Rock Island Housing Authority awarded the contract with completion in 180 days required. The work is a USHA project.

FACTORY, San Diego, Calif.

B. O. Larsen, San Diego, was awarded the contract for two 360x720-ft. final assembly buildings for the Consolidated Aircraft Co. Estimated cost of the buildings, which will be built near the present plant on the Pacific Highway, is $700,000. E. W. Taylor, San Diego, is engineer for the project.

NOTE—Additional bidding and contract news on over 800 projects, large and small, appear in the Construction News Section beginning on page 201.

WASHINGTON HIGHLIGHTS

THE CAREFULLY worked out plan for five complete and independent munitions-producing districts is out. The problem of finding enough top-flight men to manage the large number of munitions plants involved was not seen. One result is the reduction of smokeless powder plants from five to two, with the total capacity remaining the same. Grouping of other government-owned munitions plants in huge units is believed to be coming all along the line. Instead of upwards of seventy such plants there will be more like twenty.

PRELIMINARY studies for American air and fleet bases on British islands in the Atlantic show that at least $500,000,000 will be required to build them. Around $70,000,000 will be needed for the base at Trinidad alone. The money for the Atlantic bases has not yet been appropriated. It has been rumored that the Corps of Engineers will play a prominent part in this work.

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Chicago's Loop District future is discussed

The future of downtown Chicago depends on repopulation of the depopulated surrounding area according to speakers Oct. 21 before 500 property owners, realtors, architects and engineers attending a noonday luncheon of the Chicago Building Congress. From an 18-month study of the relationship between income and taxes of buildings within the district, J. Soule Warterfield, chairman, valuations committee of the County Assessors Office, stated that 70 per cent of the property is capable of earning 3 per cent. The other 30 per cent is occupied by parking lots or obsolete buildings.

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Road contractors subject to Labor Relations Act

The labor relations of a company engaged in the construction and improvement of highways used in interstate transportation are within the jurisdiction of the National Labor Relations Board, it was announced by the board recently. The ruling was handed down in connection with work being done on U.S. Highway 40 in Nevada by the Isbell Construction Co., Reno, Nev.

The board also found that the company had performed certain road work in California on U.S. Highway 395 where only residents of Nevada were employed. As a further ground for jurisdiction, the board pointed out that the company during a three-year period spent in excess of $151,000 for cement, steel, asphalt, and other building materials, of which $128,000 was manufactured or produced outside of Nevada; that it bought $72,000 worth of machinery outside of Nevada; and that an additional $89,000 worth of material, although delivered locally, was manufactured outside of the state.

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W. W. Young, sanitary engineer, dies

The recent death of William W. Young, retired chief engineer of the Westchester County, N. Y., Sanitary Commission, briefly announced in last week's issue, ended the career of one of the country's outstanding sanitary engineers. Young died suddenly at his home in Port Richey, Fla.; his age was 66. Following graduation from Princeton University in 1899 he studied at the Columbia University School of Mines. From 1905 to 1912 he was employed by the Bronx Valley Sewer Commission and later engaged in water supply and hydroelectric work. During the last World War he was engaged in training camp construction.

During his 20 years service as chief engineer of the Westchester County Sanitary Commission, he supervised the construction of a 110-mile drainage project and sewage treatment facilities costing about $30,000,000. As a consulting engineer he served many communities in the New York metropolitan area. At his death he held the advisory position of vice-chairman of the Westchester County Planning Commission.

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Headwater flood control begins at Los Angeles

The first project for the reduction of flood flows through retardation of runoff at the headwaters of streams is to be started immediately in the Arroyo Seco near Los Angeles according to the Department of Agriculture. The department was authorized to undertake this work by the Omnibus Flood Control Act of 1938. Expenditure of $1,410,000 on Los Angeles work has been approved.

Work called for under the project includes: installation of improved fire-control facilities in the mountain uplands to prevent loss of protective cover and to reduce intense runoff and soil movement from fire-stripped lands; vegetable cover improvement to increase the water retarding ability of uplands, and restoration of cover on burned-over areas; mountain channel improvement, including barriers, revetments, deflectors, and revegetation of slopes and landslides; farmland improvement through installation of soil and water conserving practices such as contour cultivation, terraces, cover crops, soil-saving rotations, tree-planting and improvements in range and pasture management; and stabilization of road cuts and fills.

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Adverse ruling upheld on Illinois wage law

The Illinois State Supreme Court Oct. 11 issued a ruling upholding the Sangamon County circuit court's decision that the Illinois prevailing wage law for public works is unconstitutional. The statute, enacted by the legislature in 1939, was held illegal on the ground that it deprived contractors and employees of the right to contract freely on wages and hours.

The court also held that the law would give officials sponsoring public works projects an "arbitrary" right to fix wages in various localities without adequate statutory restraint. The law provided that public officials should determine the prevailing wage rate before asking for bids and compel all bidders to estimate labor costs from the same scale.

The ruling follows action brought by James S. Reid, a contractor, in litigation involving construction of a bridge and approaches west of Bradfordton, Ill.

• • •

State road bodies spend less than received in 1939

State highway departments in 1939 had a total income of $1,144,064,000 and spent $1,126,929,000, including $811,656,000 for state administered highways, according to reports by the various states to the Public Roads Administration. Expenditure for state administered highways was $83,476,000 less than that in the preceding year.

A study of the expenditures shows that $467,392,000 was for highway construction and $206,014,000 for maintenance, these expenditures including $575,964,000 for work on primary state highways, $57,693,000 on secondary roads in 13 states, and $38,749,000 on urban extensions of state highways.

Total expenditures of the state highway department included $134,099,000 for debt retirement, $154,085,000 transferred for use on local roads and streets, $5,147,000 used on highways not on the state system, and $21,942,000 for non-highway purposes.

The Public Roads Administration also reported that highway users paid $1,252,205,000 in direct taxes to state treasuries during 1939. State gasoline taxes provided $821,656,000, motor vehicle fees $412,494,000, and motor-carrier taxes brought in $18,055,000.

OBITUARY

Howard Constable, 85, who was a partner in the architectural and engineering firm of Constable Bros., New York, from 1886 until his retirement in 1912, died Oct. 15 at Princeton, N. J. He was a graduate of the University of Pennsylvania.

Harvey M. Payne, 49, former assistant state engineer of Nevada, died last week at Reno. Following graduation from the University of Nevada in 1911, he was a member of the Nevada state engineer's staff under three state engineers.

W. H. Teer, 50, contractor in recent years affiliated with his brother, Nello Teer, in road construction work in western North Carolina, died in Durham, N.C., Oct. 17.

Angus McIntyre, 83, for 40 years outside superintendent of the Montreal Harbour Commission before retiring 9 years ago, died Oct. 3 in Montreal.

Wilber A. Hunt, 74, for five years previous to 1913 city engineer of South St. Paul, Minn., died recently in Morris, Minn. For a time he was connected with the Minnesota State Highway Department. He was also engineer of Stevens County, Minn., for a time.

Churchill Hungerford, Sr., 73, filtration engineer of Wenonah, N. J., and chairman of the board of Hungerford & Perry, Inc., died in Philadelphia, Oct. 16. Hungerford, president of the Inversand Co., Clayton, N. J., attended Yale University.

George P. Wood, 72, superintendent of the Peekskill, N.Y. board of water commissioners for the last 12 years, died in that city Oct. 15. In 1906 was appointed assistant engineer on the staff of the board of water supply of the city of New York and was assigned to the Peekskill division of the Northern Aqueduct Department. He left that organization in 1917.

Seth H. Belknap, 51, civil engineer with the New York Central R.R. who resided in Yonkers, N.Y., died Oct. 18.

N. E. Stone, 54, highway and bridge contractor, died Oct. 16 in Paducah, Ky., where he had maintained an office for the past ten years.

Hugh B. Gibson Dunlop, 30, inspector with the Bureau of Reclamation on the Grand Coulee Dam work, was killed Oct. 10 in a shooting accident. Dunlop, a former resident of Jamestown, N.D., was to have been transferred Oct. 16 to the Friant Dam work in California.

William H. Elrod, 42, former engineer for the St. Clair, Mo., County highway department, died Aug. 20, at Manila, Philippine Islands, where he had been employed in engineering work for the last four years.

Thomas E. Downard, 55, of Paducah, Ky. and Kentucky division supervisor of bridges and buildings for the Illinois Central R.R., died at Princeton, Ky. last week.

All-American Canal officially opened

With some 8,000 residents of the Imperial and the Coachella valleys present, the All-American Canal was officially opened Oct. 12 with a celebration at the point near Calexico, Cal. where the East High Line Canal branches off. The official occasion was the turning of the water from the All-American Canal into the bypass canal leading to the East High Line system.

The $30,000,000 canal was begun six years ago.

CONTRACTS AND CAPITAL

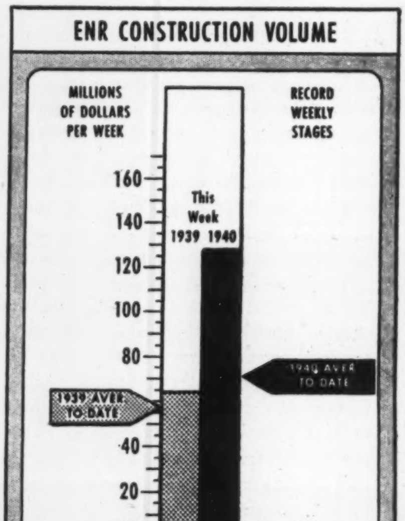
Engineering construction awards for the week total $127,317,000, a 98 per cent increase over the corresponding 1939 week, but 47 per cent below the record-breaking volume of a week ago. The rapid pace of defense awards boosts public construction 210 per cent above last year, but this volume is 46 per cent under last week. Private construction, with a 0.2 per cent gain, just tops the 1939 week, but falls 48 per cent below a week ago.

The week's awards bring 1940 construction to $3,048,061,000, 21 per cent higher than the total reported for the 1939 period, and they already exceed the $3,002,856,000 reported for the entire preceding year. Private awards are 23 per cent above the total for the 43-week period last year. Public construction tops the 1939 period by 21 per cent as a result of the 236 per cent increase in federal work.

A $26,000,000 smokeless powder plant for the War Department to be built by du Pont in Indiana, and continued awards for military and naval building construction bring public buildings to the third highest volume of the year, this volume having only been topped last week and in the week of August 22.

New capital for construction purposes for the week totals $42,416,000. This compares with $3,703,000 for the 1939 week. The current new financing total is made up of $38,725,000 in federal appropriations for river and harbor work, $2,472,000 in state and municipal bonds, and $1,219,000 in corporate security issues.

New construction financing for the year to date, $3,523,763,000, tops the 1939 volume by 58 per cent.



CONTRACTS

(Thousands of dollars)

	Week Ending Oct. 26 1939	Oct. 17 1940	Oct. 24 1940
Federal	$3,987	$148,426	$63,715
State & Municipal	25,966	24,169	29,211
Total public ...	$29,953	$172,595	$92,926
Total private ..	34,310	66,198	34,391
TOTALS	$64,263	$238,793	$127,317

Cumulative
1940 ....(43 weeks)....$3,048,061
1939 ....(43 weeks)....$2,510,314

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial building, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1939 43 Wks.	1940 43 Wks.
NON-FEDERAL	$1,105,398	$1,241,802
Corp. Securities ...	185,341	214,340
State & Mun......	434,365	427,325
R.E.A. loans......	89,445	40,000
U.S.H.A. loans....	201,647	180,465
R.F.C. loans......	4,600	195,672
Fed. Aid-Hwy.....	190,000	184,000
FEDERAL	$1,128,028	$2,281,961
TOTAL CAPITAL...	$2,233,426	$3,523,763

FHA MORTGAGES

	Week Ending Oct. 21 1939	Oct. 12 1940	Oct. 19 1940
Selected for appraisal	$23,342	$26,501	$24,517*

Cumulative
1940 .....(42 weeks)....$1,963,307*
1939 .....(42 weeks).... $944,245

* Subject to revision.

ENR INDEX NUMBERS

Index Base = 100		1913	1926
Construction Cost	Oct., '40	245.02	117.78
Building Cost	Oct., '40	204.02	110.29
Volume	Sept., '40	324	142

A.S.C.E. meeting

(Continued from p. 23)

Preparedness, and containing more than 3,100 forms returned by engineering firms, has been made available to the Quartermaster Corps of the Army, to the Bureau of Yards and Docks of the Navy, and to the Chief of Engineers of the Army. The lists have proved a valuable aid to these departments in the selection of firms to undertake immediate service to defense construction.

Contract forms for professional service on a cost-plus-fixed-fee basis have been worked out with the Quartermaster Corps, and professional services are being contracted for on this basis. The Quartermaster Corps has negotiated contracts involving $250,000,000 worth of work on the cost-plus-fixed-fee basis, a schedule beginning at 2 per cent of the cost for a million dollars worth of work to ¾ per cent for ten million.

Defense housing has had consideration of the Society's representative. Joint conferences with the representatives of the American Institute of Architects and American Society of Landscape Architects have been held to develop a contract form and appropriate schedule of fees. An allocation of the work belonging to each profession has been drafted by agreement.

Jessup reported that 1,200 names of engineers with construction experience had been submitted for possible commission in the Quartermaster Corps, but the General Staff had laid down a policy that, regardless of qualification, commissions will be granted first to qualified men who hold commission in the Reserve.

Developments of the airport construction program of the Civil Aeronautics Authority with its $40,000,000 appropriation for 250 specific airports, are being studied and the census record of engineering firms offered to CAA.

City problems

The progress of city planning was outlined by Alfred Bettman, chairman of the Cincinnati Planning Commission, and Myron D. Downs, secretary and engineer. The success of Cincinnati in putting city planning to work made this part of the program of unusual interest. Willard T. Chevalier, publisher of *Business Week*, in a spirited talk on "The Function of the City" from the physical standpoint pointed out that the great problem of the municipal engineer arises from the fact that he does not start with a blank sheet and empty area of land but, like the surgeon, must operate on a living organism. Authorities agree, he stated, that conditions can be improved only by a constructive urban land policy that will control growth in the interests of the entire community and one that assures a density of population adequate to support the necessary public services at a reasonable per-capita charge.

E. B. Black, consulting engineer, Kansas City, Mo., in his paper on "Civic Responsibilities of the Engineering Profession" held that the engineer has accepted and performed them. Furthermore, the engineer is coming to the conclusion that his civic responsibilities are at least equal to, and probably exceed those of, the average citizen. The record of the profession in this respect is one of which we may justly be proud, is Black's opinion.

Frank C. Tolles, consulting engineer, Cleveland, in a discussion of municipal sanitation, outlined the sewerage situation in Cincinnati which he summed up as one of correcting a local nuisance, but more essentially of obtaining protection against a water supply hazard which is occasioned by up-river pollution. Sewage treatment at Cincinnati may therefore be regarded as a means of trading—of furnishing protection to down-river communities in exchange for protection from up-river pollution.

Municipal transportation was discussed by E. P. Goodrich, consulting engineer, New York City, using downtown Cincinnati as an example. Here he pointed out, a complete subway loop for all mass transportation would be the best solution and one which could make use of the $6,000,000 uncompleted subway initiated many years ago. If sub-surface sidewalks are included, Goodrich claims Cincinnati would possess the most complete and efficient traffic and transit system of any city in the country.

Harold M. Lewis, chief engineer, New York Regional Plan Association, Inc., presented a thought-provoking paper on "Esthetic Responsibilities of the Engineer" and illustrated it by numerous good and bad examples of structures, such as bridges, highways, water tanks and sewage disposal plants. The responsibility, Lewis stated, of getting the engineer to give proper consideration to esthetics rests on the educator, the employer or supervisor, and the individual himself.

C. O. Sherrill, city manager of Cincinnati, closed the city-problems discussion with an excellent outline of municipal organization from the engineer's viewpoint. He issued a warning that national good government could only be had through good city governments. Young engineers will find no more attractive field than that of city service and their training fits them especially for administrative as well as engineering in Sherrills' opinion.

Sanitary division

A new bio-chemical sewage treatment plant (Guggenheim process) at Anderson, Ind., was described by B. A. Poole, chief engineer, Indiana State Board of Health. The plant has a capacity of 8 mgd and employs primary sedimentation tanks of two-hours detention, aeration or mixing tanks (2 hr.) and final settling tanks (2.27 hr.). A single digester takes primary tank sludge and scum as well as sludge from a thickener. Operation results achieved since June when the plant was started show that reduction in biochemical oxygen demands range from 92.7 to 96.4 per cent, and that suspended solids removal ranged from 94.5 to 99.1 per cent. Wastes from a clay products plant make suspended solids in the new sewage higher than normal. Iron applied varied from 2.8 to 4.5 ppm and air from 0.39 to 0.45 ppm. F. H. Waring, chief engineer, Ohio State Board of Health, gave four week's results from a similar plant of 2¼-mgd capacity at Cuyahoga Falls, Ohio. Here the B.O.D. reduction was 93 per cent and the suspended solids removal was 61 per cent.

Power division

Most interesting of several papers presented before the power division was one on "Economic Design of Waterways and Gates for Hydroelectric Developments" by G. R. Rich, head mechanical engineer, and Ross M. Riegel, head civil engineer, design department, TVA, which was fully discussed by A. T. Larned, Phoenix Engineering Corp., New York. The paper and discussion point out that dams have been simplified, economic size of waterways has been determined, complicated approach structures to intakes have been cut out, support of turbine casings has been reduced to a minimum and horizontal sections of draft tubes have been utilized as foundation supports for auxiliary equipment. These are some of the important contributions toward better and more economical hydroelectric plants.

City access roads

Considerable discussion was devoted to a comparison of use of a gantry crane or individual motor drives on spillway gates.

Hal G. Sours, state highway engineer of Ohio, pointed out that providing adequate trunk routes into and through cities is the greatest problem facing highway engineers today. High cost of right-of-way in urban areas is blocking the development of access routes in the larger centers of population. He declared that the municipalities cannot and should not bear the entire cost of trunk highways within their borders. A suggested method of financing these much-needed improvements is by federal loans to cities and counties for purchase of right-of-way, preserving present available funds for construction costs, or purchase of the land by the federal government on the basis of repayment over a term of years by the cities and counties. Sours believes the final title to all right-of-way should rest with the local agencies and not with the federal government.

EDITORIALS

VOLUME 125 NUMBER 17

October 24, 1940

On Its Mettle

CONSTRUCTION is now our front line of defense. Enlisted for the duration, the industry for some time to come will hold the key to the success of our national defense effort. And things are beginning to hum. Airbase work is rising to a peak. Cantonments and munitions plant construction are getting under way after a long and anxious wait. The two-ocean navy requirements were defined with a rush, and shipyard expansion has begun. Throughout the nation a job of huge size must be carried out rapidly and efficiently. It will test the mettle of the construction industry. But working in partnership with the construction forces of the Army and Navy, which are doing their part with praiseworthy speed and skill, there should be no doubt of the outcome. That there will be problems of organization, manpower and materials seems certain. That rising prices will cause trouble for contractors is probable. That civil construction may have to take second place to defense construction is possible. In meeting any or all of these problems, knowledge of what is being done, of how it is being done, and of future requirements is essential to success. It is the purpose of this issue to make a start in supplying that knowledge and a cardinal principle of this journal to continue to keep that knowledge up to date.

Complementary Functions

STRUCTURAL ENGINEERS who have complained that architects look on engineering service as a commodity to be purchased, thus lowering the prestige of engineers, will be interested to learn that the picture looks different from the viewpoint of at least some architects. Speaking to the New York State Association of Architects recently, George A. Boehm, New York architect, said, "The architect has allowed some functions to fall out of his hands that he should have retained. One of the most vital elements in all building is found in the problem of stability of structure. Gradually the structural engineer has been allowed to usurp this part of the designing function with a consequent further loss in the architect's prestige." But has the architect really lost any prestige? Is it not rather that the public through increasing knowledge has come to recognize that much more is involved in a modern building than form and facade and now gives to the three professions—architects, engineers and builders—far more credit than the one got back in the days of "master builders." No man combines the artistic conception, structural design ability and organizing acumen that is needed to plan, design and build a great building. No man loses prestige through acknowledgment of that fact. Conceivably the public has been quicker than many architects in recognizing that architect, engineer and builder are complementary.

Death Rays Serving Mankind

ULTRA-VIOLET RAYS, already an agent of importance in food and air sanitation, may prove to be of significant interest to sanitary engineers for water and perhaps sewage sterilization. Experimental work with a "death ray," recently described by Harvey Rentschler, director of research, Westinghouse Lamp Division, indicates that all kinds of bacteria meet sudden annihilation when they are exposed to invisible ultra-violet radiations. Used since 1878 for water disinfection, the ultra-violet light process has found only limited application, principally because of the high cost. This cost is now being reduced, and new knowledge on the generation and application of these rays may be expected to do much to stimulate further studies on their application.

Too Late in 1945

IF POWER from the International Rapids Section of the St. Lawrence River is to be ready to take over the peak load of defense industries in 1945, preliminary investigations, surveys and borings must be made immediately, according to the President in a message sent to Congress on Oct. 17 stating that he had ordered such studies to be started at once. In other words, *four years* from now war industries will be calling for more power. We can't believe it. We cannot believe that this country will not be well past the peak of intensive preparedness long before 1945. The conclusion is inescapable that the war emergency is being used as an excuse to start a project that has been turned down repeatedly by Congress. Expenditure of millions of dollars on that project at this time when the country is being loaded down with the cost of the immediate needs for defense is without justification. As was pointed out in comment on the international power situation in these pages two weeks ago, large blocks of power can be developed quickly as emergency measures at Niagara and at the Beauharnois plant in Quebec at a fraction of the cost of developing the International Rapids. The first step in that direction has since been taken. No money should be spent at this time on projects that can serve no useful purpose until 1945.

Haste Can Make Waste

OUR NEWS PAGES of three weeks ago carried a reprint of a 1917 article which told of a cantonment building being constructed in 3 hours by 200 men. The story was republished at the suggestion of a constructing quartermaster to give present-day constructors something to shoot at. Without in any way belittling such an achievement, even when done solely for spectacular news value, it appears that the method of construction now employed at Fort Dix, N. J., and undoubtedly at other cantonments, may have a much better overall effect. At Fort Dix relatively few men work on any building at one time; instead small crews do a "production line portion" of the work on one building, then pass to the next building, while their place is immediately taken by another crew in the construction production line. This method appears to have the advantage of avoiding confusion, which speeds up the work, and it may serve to prevent the retelling of the story about carpenters sawing on both ends of the same board.

Professional Work Defined

LAST WEEK THE WAGE AND HOUR DIVISION of the U. S. Department of Labor announced new definitions of the terms executive, administrative and professional as used in the Fair Labor Standards Act of 1938. Offhand, this redefinition of professional employment may not appear to be important, but when its implications are recognized it may be that the new definitions will prove to be a milestone in the efforts of engineers to strengthen their standing as professional men.

The act in question exempted "employees employed in a bona fide professional capacity." Early rulings on the act interpreted the term professional quite narrowly, which had the effect of including within the limits of the act a large group of engineers in both professional and industrial offices who would not otherwise be included under the provisions of an act designed to protect low-paid employees from exploitation. To escape possible attack for violation of the act, employers of these men had to require that their time be kept just like that of men in less responsible positions; and because the penalty for overtime work under the act is high, the practical effect has been a lot of "clock punching" on the part of men who had little interest in watching the clock.

The new ruling (*ENR*, Oct. 17, 1940, p. 504) considerably enlarges the scope of the term "professional," more clearly defines the type of work that should be included and, by setting a minimum salary of $200 a month as a basic requirement for anyone to be included in the professional class, definitely eliminates the possibility of an employer using a professional classification for the exploitation of low-paid men. The new ruling also makes it possible to include in the professional group men who put in part of their time on routine operations. This is especially important in engineering offices where men are called on for a variety of work in the interests of efficiency.

The Wage and Hour Division is to be commended for what it has done to clear up a bad situation and for its courage in taking this action despite strong opposition on the part of interested unions to any broadening of the scope of the terms executive, administrative and professional.

For what the Wage and Hour Division has done to clear up a bad situation for engineering employees, the engineering profession itself can take no credit. Not one of the organizations that profess to be working for the advancement of engineering as a profession was represented at the hearings on the subject. Only Alexander Maxwell of the Edison Electric Institute argued the cause of the engineers. The ball was carried by the manufacturers; and as a result, the unions quite naturally see in their interest an ulterior motive. If the new ruling is to stand, those who believe it to be sound and beneficial to the engineering profession will have to do more than sit on the sidelines.

ENGINEERING NEWS-RECORD

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Comment and Discussion

Readers' opinions on matters that concern engineers and contractors

Median Strip Shrubbery

Sir: In the *ENR*, Aug. 22, 1940, Picture Page there is a description of the New London, Conn., four-lane highway, divided by a wide median strip that "ultimately will be planted with trees and shrubs. . . ." Why with trees or many shrubs? The median strip itself avoids the danger from the glare of approaching lights and trees would decrease visibility and unless very carefully placed would decrease, if not entirely spoil, the beauty of long grassy stretches. Trees and shrubs would also increase the work of maintaining the grass. An exception might be made and shrubs planted to mark openings through the center strip either for crossroads or for a chance to turn back into the opposite direction.

Henry E. Warren
Middleboro, Mass.

Rigid Frames—A Criticism

Sir: Referring to the article in the July 18, 1940 issue, p. 91, headlined "Welded Rigid Frames, European Style," I find it difficult to understand why the designer chose a typical concrete outline for a steel structure; especially when it is entirely not suited for American economical conditions. "The transition sections 'A' provide for full continuity between the girders and the interior columns," it is claimed. What is full continuity in this case? It is apparent that the columns take very little moment under any condition of loading, and it would be of advantage to neglect the rigidity of the column entirely and design the girders continuous, assuming hinge supports; of course, when designing the columns, the small bending caused by the actual rigidity of the joint would need to be considered. The amount of bending going to the columns can very well be transmitted by angle connections, while the bigger moment over the supports is developed by flange plates. This suggested design, I believe, is neat and would better express the character of the material.

The author of the article mentions difficulties in connection with such design in the nature of various peculiar stresses developed in "such sharply curved joints". The moral should be not to use them unless unavoidable. Such is surely not the case in this instance.

Attention is called to a discussion of such joints by Prof. Gehler's treatise, "Der Rahmen"—3rd ed. pp. 255-272. Also "Forschungsarbeit". The influence which such short haunched joints have on the rigidity of the structure is negligible and therefore is mostly of theoretical interest. (See A. Strassner, "Berechnung statisch unbestimmter Systeme"—Vol. I, 2nd ed. p. 133. Also by the same author "Neuere Methoden"—3rd ed. Vol. I p. 74).

From a standpoint of appearance: A glance at Fig. 1 (the photograph at the head of the discussed article) discloses that the columns practically disappear from sight and that it would be more to the advantage of the esthetic appearance of the structure not to call attention to the columns by such prominent and expensive joints. There is a good chance with this kind of structure to relegate the columns still more effectively by making the facing plates wider. Such arrangement of column spacing which is well used by the designer with the suggested slight change would give more prominence to the horizontal line and so produce better the expression of beam action. (The writer has obtained a very good result in this respect by so relegating columns in connection with a similar bridge through a park and having the vertically curved deck appear as an arch, spanning between the two utility houses buttressing it at each end.)

About welding versus riveting in general: Rivets lend to a steel structure a very pleasing appearance and under certain circumstances they can be made an architectural feature. Excepting in the case of trusses there are very few cases in the construction line where welding is definitely economical so far, especially, for field connections. Shop-welding mostly comes even in cost to that of riveting and is advantageous for certain types of construction, especially for small parts. The advantage of welding trusses lies not only in the economy of material (absence of gusset plates, rivet heads and cross-sections not reduced by holes) but also in the fact that the short joint connections reduce secondary stresses materially. There is, however, the discouraging feature in connection with welding of important and huge structures of any shape that efficient inspection is elaborate and expensive.

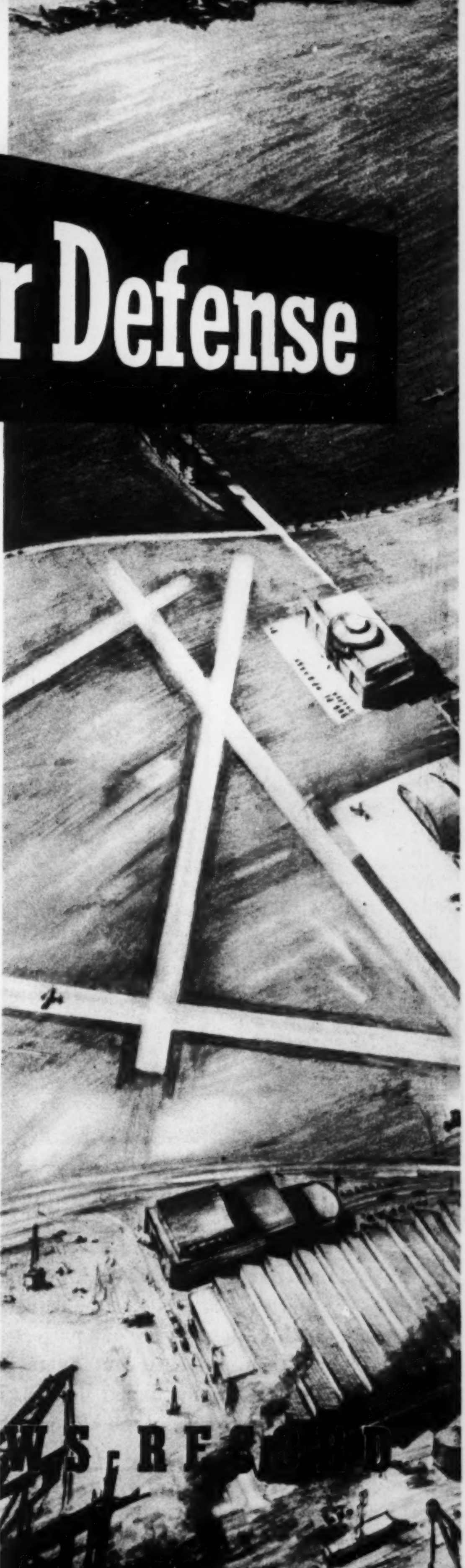
Arnold A. Weitzman
Structural Engineer
Chicago, Ill.

Weight of Pile Hammers

L. H. Buttenheim, vice president, McKiernan-Terry Corp., makers of piledriving equipment, in a letter published in our issue of Aug. 29, raised question as to weight of pile hammers called for in a report of the committee on wood bridges and trestles of the American Railway Engineering Association abstracted in our issue of Aug. 1, p. 54. The committee recommended that for driving concrete piles, the striking part of the hammer should develop energy per blow of 8,750 foot-pounds per cubic yard of concrete contained in the pile to be driven. Mr. Buttenheim pointed out that this is far in excess of current practice and, if followed, would require a hammer more powerful than any built. Because this requirement appeared so extreme, Mr. Buttenheim raised question as to whether the figure of 8,750 foot-pounds was not a typographical error in printing the committee report.

Since publishing Mr. Buttenheim's letter we have learned that no such error occurred, that the figure given is that contained in the committee's report as finally adopted. When the subject came up for discussion in the general committee there was a wide divergence of views, the subcommittee that had made a special study of the subject recommending a figure more in line with current practice. But the subcommittee was overruled by the main committee and the higher figure was adopted. It is understood that the subject is still under discussion and probably will receive further attention in the 1941 report of the committee.—Editors.

Building for Defense



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ENGINEERING NEWS-RECORD

OCTOBER 24, 1940

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ENGINEERING NEWS-RECORD, OCTOBER 24, 1940

Building for Defense

During the past six months the construction industry has been called to arms. As in 1917 the job is on an emergency basis. Training camps, housing and factories must be built before the men and munitions required for national defense can be turned out. The Navy, through its Bureau of Yards and Docks, the Army, through the Office of the Quartermaster General, are the spearheads of the construction attack. Civilian engineers are being used extensively. Most work is by contract. The Federal Works Agency has prominent place. How, where and for what 2 billion dollars of construction money is to be spent is the story of building for defense.

GERMANY INVADED POLAND on September 1, 1939, and on September 16, 1940, the United States, having previously voted to double its navy, enacted a selective service law to increase its army threefold to 1,400,000 men. From cause to effect, the time elapsed was just 12 months and 2 weeks.

No generation in world history has been required to digest events so rapidly. A year ago the United States occupied comfortable seats on the sidelines, watching from a distance a developing game of war. Today, the seats are still ours but they are vacant, their occupants having retired to practice fields behind the stadium to prepare to resist any tendency for the game to get out of hand. The preparations are as tremendous, as swift and as dislocating to our accustomed mode of life as the events which inspired them.

No division of our economy is unaffected, least of all the construction industry, whose activities must pave the way for effective war preparation. How these activities have been turned from peaceful objectives to those concerned with national defense in a period of less than six months is well worth recording. A picture of the magnitude of the job, its problems and its requirements, coupled with an outline of the construction program and the organization that is being welded to carry it out, constitutes this record. To its presentation, this issue of *Engineering News-Record* is devoted.

A look backward reveals that construction was following its normal peacetime course for the first quarter of the 1940 year. Recovery from depression emergency conditions was progressing steadily. Housebuilding was increasing, public utilities were expanding facilities, cities were beginning to reassume responsibilities for municipal improvements that they had relinquished to PWA and WPA, and factory building was rising in response to war demands from Europe and to Latin-American requirements. Yet before the 76th Congress recessed for the election, it had voted, in money or contract authorization, over thirteen billion dollars for defense of which 1½, perhaps 2, billions will go for construction. Thereby, the whole complexion of the construction industry was changed. A review of events relating to defense legislation illustrates how this change came about.

How the defense program began

A logical starting point is the spring of 1939. As crisis after crisis arose in Europe, with the certainty of an eventual explosion, sentiment in Congress began to encompass preparedness. Action, however, was pretty leisurely. A 1938 report of a board of naval officers, to the effect that the Navy's shore facilities needed great expansion, led to Congressional approval, in April, 1939, of a three-year program of naval airbase development in the Pacific area and along the Atlantic Coast. But not until August, nearly five months later, when Germany took over Czechoslovakia, was any money appropriated. By that time new airbase requirements of the Army Air Corps had also been brought into the picture.

The bill, a 2-billion-dollar one, has since become known as the initial defense appropriation act. It provided 63 millions for navy airbases, six in the Pacific Islands, two in Alaska, one in Puerto Rico, and five along the Atlantic coast; 62 millions for army airbases, (including a northeast base at Chicopee, Mass., a southeast base at Tampa, Fla., and bases in Puerto Rico, Alaska and the Canal Zone); and miscellaneous millions for other navy and army public works, principally in Panama.

For nine months nothing occurred to disturb satisfaction with the status quo. Finland and Norway were a long way off. France and Britain were set for a three-year defensive war. The Navy was rushing its work in the Pacific, but elsewhere there was no sign of hurry.

Suddenly, in May, France collapsed. As if an alarm clock had gone off, Congress woke up and be-

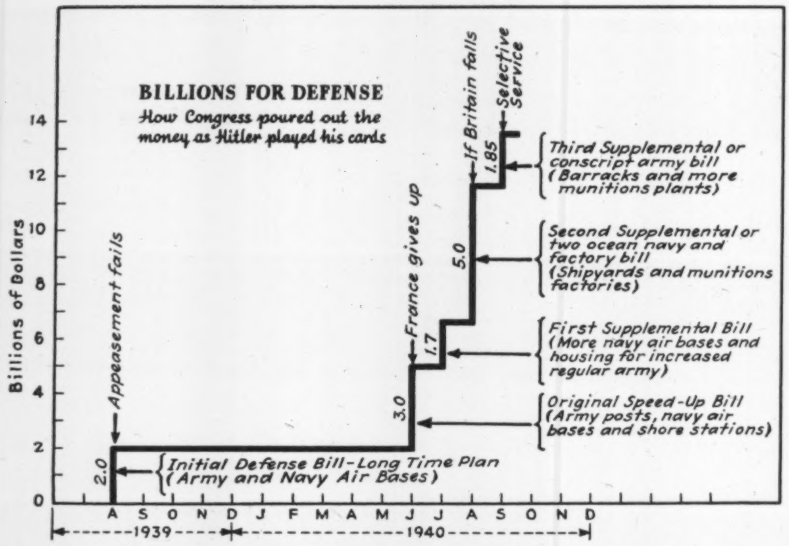


Chart of defense appropriations illustrates modest start in 1939 and feverish stepup that began in June, 1940. Total reached 13.5 billions, of which at least 1.5 billions is for rush construction.

gan to legislate. Each month thereafter—June, July, August, and September—a bill was passed, as charted above, appropriating or authorizing billions for defense.

The final score was $13,500,000,000 of which nearly $2,000,000,000 was for construction and had to be spent immediately. How was the Army and Navy going to get the money into contracts?

How the Navy functions

Construction department of the Navy is the Bureau of Yards and Docks. One of the most efficiently managed of federal construction agencies, the Bureau had an existing organization capable of planning and supervising a large program.

Two well considered decisions had been made early in 1939 when planning for the long-range expansion of shore facilities began, namely, to farm out design work to private firms "in a deliberate effort to acquaint the country's engineers and architects with its requirements," and to let contracts on a negotiated cost-plus-fixed-fee basis, "in the interest of speed and economy." Both decisions proved wise, for the Bureau's program went into high gear immediately.

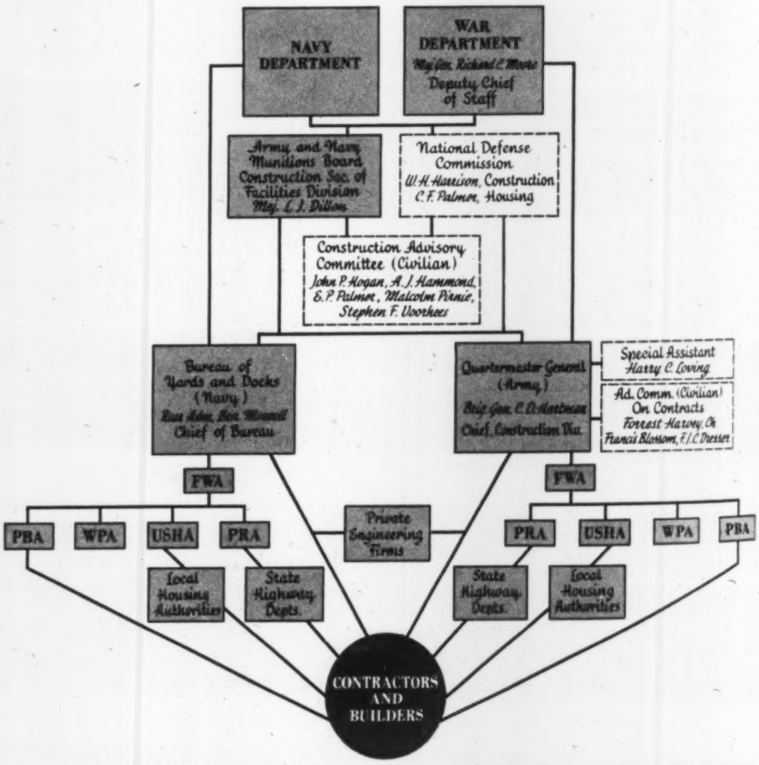
Specifications, of course, are drawn up in Washington, and design and construction contracts are negotiated personally by the Chief of the Bureau there. Large, all-inclusive contracts are the rule.

Just as soon as a Navy construction contract is signed, a Bureau public works officer and two or three assistants are ordered to duty at the site, the senior officer becoming in effect a member of the contracting firm. From then on the job is divorced from Washington, and the local Bureau-contractor partnership is on its own, scheduling work, ordering materials and meeting payrolls. When the work is at an existing shore station the procedure is even simpler, for then the resident public works officer is in charge.

Who builds for the Army

Construction work for the Army is the responsibility of the construction section of the Office of the Quartermaster General. Top officer is the Constructing Quartermaster General, and at each site of work there are the local constructing quartermasters. The Army also has a construction officer superior to the Quartermaster General who, as a deputy chief of staff, coordinates all construction planning with military objectives.

The Army, which also has authority to use negotiated contracts, has until recently elected to handle most of its work by the competitive bid method. It also uses numerous small contracts at a given site instead of a single large contract. An exception is the use of large negotiated fee contracts for some of the cantonments and for the agency munitions plants under which a private organization is engaged to design, build and operate the facilities. For the detailed provisions of both the Army and


NAVY DEPARTMENT
WAR DEPARTMENT Maj. Gen. Richard C. Moore Deputy Chief of Staff
Army and Navy Munitions Board Construction Sec. of Facilities Division Maj. C. J. Dillon
National Defense Commission W. H. Harrison, Construction C. F. Palmer, Housing
Construction Advisory Committee (Civilian) John P. Hogan, A. J. Hammond, E. P. Palmer, Malcolm Pirnie, Stephen F. Voorhees
Bureau of Yards and Docks (Navy) Rear Adm. Ben Moreell Chief of Bureau
Quartermaster General (Army) Brig. Gen. C. D. Hartman Chief, Construction Div.
Special Assistant Harry C. Loving
Ad. Comm. (Civilian) On Contracts Forrest Harvey, Ch. Francis Blossom, F. I. C. Dresser
FWA
FWA
PBA
WPA
USHA
PRA
Private Engineering Firms
PRA
USHA
WPA
PBA
Local Housing Authorities
State Highway Depts.
State Highway Depts.
Local Housing Authorities
CONTRACTORS AND BUILDERS

How and by whom national defense construction is being handled. *Temporary advisory committees and commissions are shown unshaded.*

Navy negotiated fixed-fee contracts, see *ENR,* Aug. 15, 1940, p. 229.

Coordination of defense organization

The agencies that have important functions in the national defense construction program and their relations to one another are charted on the previous page. Those which have been set up since the emergency and are therefore temporary in nature are shown unshaded in broken lines. Of these the key body is the National Defense Advisory Commission made up of high ranking industrial leaders whose job is to coordinate all defense activities relating to accumulation of strategic materials, to production of munitions and supplies and to award of defense contracts, including those for construction. A construction contract proposed to be let or negotiated by a government agency must first be approved by the Commission, which studies its effect on work already let and in prospect. The construction division and the housing division of the Commission have this work in immediate charge.

Through its authority to approve contracts for acquisition of war munitions and equipment the Defense Commission also controls much of the private industrial expansion that is taking place. How large this is is indicated by the fact that industrial building awards for the first nine months of 1940 as reported in *Engineering News-Record* total $350,000,000 as against only $170,000,000 in the same period in 1939, and the 1940 figure does not include over $150,000,000 of munitions plants which are government owned and therefore listed as "public buildings." Money for this factory expansion has come from banks, company reserves, RFC loans and, for the government-owned private-operated plants, from the defense appropriations.

Role of other agencies

In addition to the Army and the Navy, other departments of the government, most of them divisions of the Federal Works Agency, are active in the national defense effort, usually, however, on orders or authorization from the two service arms. Thus WPA is devoting its funds wherever possible to national defense construction at army posts and navy establishments. Latest estimates are that about a quarter of its appropriation, or $250,000,000, will go for this purpose. The USHA, although unsuccessful in attempts to get special money for defense housing, has devoted about $30,000,000 of its available funds to projects in defense centers. Although built by the local housing authorities in accord with the USHA plan, local contribution is waived and no subsidy is to be applied. Major defense-worker housing appropriation ($150,000,000) was, however, given this month to the Federal Works Agency, which will spend at least part of it through the Public Buildings Administration. Finally, the Public Roads Administration has authority to direct large amounts of federal-aid money to strategic highways; some say that the entire $800,000,000 in federal and state funds, available in the next two years, will be spent on our defense road system, but a conservative estimate of PRA's contribution would probably be about $200,000,000.

How engineers and contractors help

Already many civilian engineers and contractors have been drawn into the national defense effort. One of the earliest developments was the appointment by the Army and Navy Munitions Board of an advisory committee of engineers and contractors to aid in its construction planning. This committee has advised on forms of contract and on personnel available, one of its acts being the institution of the census of engineers conducted by the American Society of

TABLE 1—HOW CONGRESS VOTED BILLIONS FOR DEFENSE

		Total	Est. for Const.
Aug., 1939	Initial Defense Bill.............	$2,000,000,000	$200,000,000
June, 1940	Original Speed Up Bill.........	3,000,000,000	225,000,000
July, 1940	First Supplemental Defense Bill,..	1,700,000,000	380,000,000
Aug., 1940	Second " " "	5,000,000,000	620,000,000
Sept., 1940	Third " " "	1,800,000,000	550,000,000
	Totals........................	$13,500,000,000	$1,975,000,000(1)
Additional from Federal Works Agency and others...............			720,000,000
	Est. Total of Construction Money.......................		$2,695,000,000

(1) This total includes perhaps $500,000,000 for equipment in munitions plants which is not strictly construction.

TABLE 2—WHAT CONSTRUCTION MONEY IS TO BE SPENT FOR

Navy		
Continental Airbases......................	$160,007,000	
Pacific Airbases..........................	40,047,000	
Alaskan Airbases..........................	17,555,000	
Panama and Caribbean Airbases..............	33,570,000	
Continental Yards and Establishments..........	213,756,000	
Non-Continental Yards and Establishments.....	63,588,862	
Agency Shipbuilding and Ordnance Plants....	200,000,000	
Defense Worker Housing...................	50,000,000	$778,523,862
War Department		
Draft Army Training Camps..................	330,000,000	
National Guard Training Camps...............	100,000,000	
Army Posts................................	100,000,000	
Continental Airbases.......................	100,000,000	
Alaska, Hawaii & Panama Airbases...........	25,000,000	
Agency Munitions Plants....................	500,000,000	
Defense Worker Housing...................	50,000,000	$1,205,000,000
Federal Works Agency and Others		
PRA—Highways...........................	200,000,000	
CAA—Airfields...........................	40,000,000	
PBA RFC —Housing....................... USHA	230,000,000	
WPA—Misc. work at Navy Yards, Army Posts,	250,000,000	$720,000,000
Est. Total..................................		$2,703,523,862

TABLE 3—LOCATION AND SIZE OF CONTRACT FOR MAJOR PROJECTS

Army Airbases	
Hill Field, Utah	$2,800,000
Westover Field, Mass	6,000,000
Lowry Field, Colo	4,600,000
MacDill Field, Fla	3,000,000
Albrook Field, C. Z	8,500,000
Patterson Field, Ohio	1,500,000
Wright Field, Ohio	1,300,000
Chanute Field, Ill	7,300,000
Scott Field, Ill	2,682,000
Mobile Air Depot, Ala	3,500,000
Ellington Field, Tex	1,000,000
Savannah Ga. Airport	1,550,000
March Field, Calif	4,042,000
Anchorage, Alaska	1,800,000
Elmendorf Field, Alaska	1,700,000
Hickam Field, Hawaii	6,700,000
Wheeler Field, Hawaii	1,500,000

Army Training Camps	
Fort Shelby, Miss	$9,760,000
Fort Knox, Ky	1,900,000
Fort Jackson, S. C	5,500,000
Fort Benning, Ga	3,800,000
Fort Ord, Calif	3,100,000
Fort Dix, N. J	7,400,000
Savannah, Ga	2,700,000
Camp Blanding, Fla	9,100,000
Camp Edwards, Mass	7,700,000
Fort McClellan, Ala	3,360,000
Fort Bragg, N. C	4,000,000

Army Training Camps (Cont.)	
Camp Robinson, Ark	4,700,000
Bringhurst Forest, La	4,300,000
Beaver Creek, La	4,250,000
Brownwood, Tex	4,190,000
Fort Lewis, Wash	10,260,000
Fort Custer, Mich	2,800,000
Indiantown Gap, Pa	5,414,000
Camp Corundu, C. Z	3,500,000
Camp Peay, Tenn	8,638,000
Fort Meade, Md	7,354,000
Camp Merriam, Calif	3,880,000
Fort Bliss, Tex	3,046,000
Camp Hulen, Tex	1,628,000
March Field, Calif	1,030,000
Fort Devens, Mass	5,000,000

Army Arsenals and Depots	
Edgewood Arsenal, Md	$5,000,000
Picatinny Arsenal, N. J	1,200,000
Frankford Arsenal, Pa	1,403,000
Savannah, Ill., Depot	3,100,000
Ogden, Utah, Depot	1,000,000
Jeffersonville, Ind., Depot	1,200,000
Philadelphia Depot	950,000

Navy Airbases	
Jacksonville, Fla	$29,760,000
Corpus Christi, Tex	28,000,000
Quonset, R. I	25,204,000

Navy Airbases (Cont.)	
Miami, Fla	3,500,000
Pensacola, Fla	10,105,000
Alameda, Calif	14,810,000
Tongue Point, Ore	3,500,000
Norfolk, Va	12,710,500
San Juan, P. R	12,239,000
Kodiak, Alaska	11,255,000
Sitka, Alaska	3,400,000
Kaneohe Bay (Pacific)	12,263,000
Pearl Harbor, Hawaii	8,234,000
Midway Island (Pacific)	9,200,000
Johnston Island "	1,650,000
Palmyra Island "	1,100,000
Wake Island "	7,600,000
Unalaska, Alaska	2,900,000
Coco Solo, Canal Zone	15,814,000
Seattle, Wash	4,250,000
Quantico, Va	1,689,000
Guantanamo, Cuba	3,475,000
Charlotte Amalie, V. I	2,042,000
San Diego, Calif	5,600,000
Squantum, Mass	211,000
Philadelphia, Pa	2,190,000
Anacostia, D. C	16,000
Cape May, N. J	350,000
Key West	125,000
Parris Island, S. C	285,000
Auxiliary Air Bases	10,000,000
Reserve Aviation Bases	10,000,000
Neutrality Patrol Facilities	7,000,000

Agency Plants (Navy)			
Shipbldg,	Orange, Tex	(Consolidated Steel)	$4,600,000
"	Manitowoc, Wis	(Manitowoc Ship)	1,000,000
"	Seattle, Wash	(Seattle-Tacoma Ship)	4,600,000
"	Groton, Conn	(Electric Boat)	2,750,000
"	Newport News, Va.	(Newport News Ship)	14,000,000
"	San Francisco, Calif.	(Bethlehem Steel)	10,013,000
"	San Pedro, Calif	(Bethlehem Steel)	2,756,000
"	Quincy, Mass	(Bethlehem Steel)	13,427,000
"	San Pedro, Calif	(Los Angeles Ship)	450,000
"	New York, N. Y	(Bethlehem Steel)	2,706,000
"	Chickasaw, Ala	(Gulf Ship)	2,500,000
"	Bath, Maine	(Bath Iron Works)	1,600,000
"	Camden, N. J	(New York Ship)	10,500,000
"	Kearney, N. J	(Federal Ship)	5,500,000
Ordnance		(Bethlehem Steel)	23,607,700

Agency Plants (Navy) Cont.			
Ordnance		(Carnegie-Illinois)	5,354,000
"	Camden, N. J	(Camden Forge)	2,873,695
"	Titusville, Pa	(Struthers-Wells-Titusville)	907,720

Agency Plants (Army)		
Shell Loading, Ravenna, O	(Atlas)	$14,200,000
Powder, Radford, Va	(Hercules)	25,000,000
Powder, Charlestown, Ind.	(DuPont)	25,000,000
TNT, Wilmington, Ill	(DuPont)	10,800,000
Tanks, Detroit, Mich	(Chrysler)	20,000,000
Airplane Engines, Detroit, Mich.	(Packard)	14,750,000
Shell Loading, Wilmington, Ill.	(Sanderson & Porter)	14,000,000
Toluol, Baytown, Texas	(Humble Oil)	9,500,000
Shell Mfg., Gadsen, Ala	(Lansdowne Steel)	6,000,000
Armor Plate, Philadelphia	(Henry Disston)	1,000,000
Shell Loading, Union Center, Ind.	(not announced)	14,000,000

Civil Engineers and other societies.

Engineers have also been called into positions on the Defense Commission, and others have constituted an advisory committee to the Constructing Quartermaster to handle a census of contractors available for army work and to supervise the details of negotiating cost-plus-fixed-fee contracts. Some 1,200 contractors and over 300 engineering firms have been catalogued as to ability and availability by this board.

The use of private engineering firms to design Bureau of Yards and Docks work has given employment to several thousand engineers, while the Army has accounted for several thousand more on the munitions plant program. To these should be added the engineers and architects on defense housing projects. Most recently the Army has started hiring engineering firms to design training camp facilities, and this has swelled the ranks of civilian engineers on national defense.

Where the money is going

Consideration of what is being built, and where and with what, has been left to the last. In Table 1 is presented a list of the congressional appropriations that have been made, together with the estimated portions that will be spent on construction.

All this money is to implement the Army and Navy plans which are now rather well outlined. A high-ranking officer has said that, "Construction is the hub around which the Army's expansion program rotates." He points out how all approaches to the armament problem lead through the construction industry. For example, if we consider national defense in terms of manpower —1½ million men by July, 1941—we think at once of cantonments and training centers; and these mean not only barracks but recreation halls. motion picture theatres, motor sheds, gun parks, and many other substantial structures.

If the armament program is regarded as a problem in munitions production and procurement, the role of construction becomes even more significant. First, the existing arsenals had to be expanded to handle the first stages of our demand for such items as tanks and guns. This, however, is less than ten per cent of the armament load, and for the remainder we must look to civilian production of munitions, for which there were no facilities. New factories for the production of planes, guns, powder and other munitions had to be built and are being built rapidly. This Army officer further points out that the munitions program includes sufficient stocks of critical items of equipment to take care of an army of 2 million men; and to provide the plants to produce these munitions and to house those now who will construct them, and later those who will be employed in them, will demand the services and the resources of the entire construction industry.

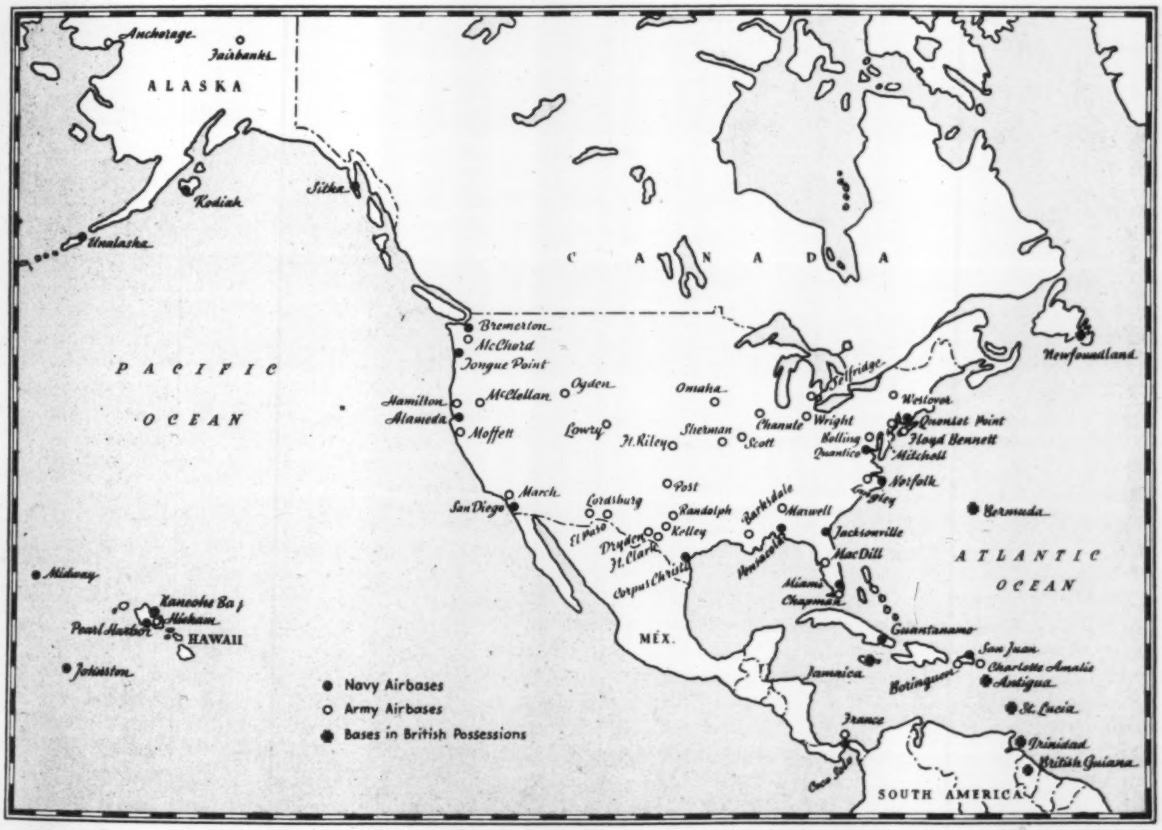
To meet the Navy's needs, the construction industry has an equally important role. A Navy is something more than a battle fleet at sea. It calls for elaborate shore installations. First contracts on such shore facilities were let two weeks before the European war began, and the principal effect of the war has merely been to accelerate this work. The decision to build a so-called two-ocean navy, however, was not in the original plans, and the effect of this has been to add new items such as ways, drydocks, warehouses and shops.

The acquisition of bases on British Caribbean possessions will also tend to increase the scope of navy construction operations. Finally, the Navy, too, rests upon the munitions industry for its support, and its requirements call for new plants which give rise to construction problems similar to those outlined for the Army.

How this construction money totaled in Table 1 is going to be spent is detailed in Table 2, which is an estimate based on best available data. Where the major jobs are located is presented by Table 3.

Our *front* line of defense may be in a variety of places but our *first* line of defense is the construction industry. In trying to meet the national defense needs for construction today, the country is much better prepared than it was in 1917 when confronted with a similar expansion program. In the first place, the Army and the Navy know what they want. The Industrial College studies and the industrial mobilization plans have given the armed services a better understanding of the powers and limitations of industry. And, conversely, industry has enjoyed a closer association with army and navy officers in the years since the World War.

Thus with the money available, the Army and Navy objectives known, the Army and Navy construction divisions manned and organized for their jobs and the resources of civilian engineers and contractors marshalled to tasks that in their various elements are not greatly different from those they have handled so effectively in peacetime, our national defense effort on the construction front is pointing down the road to successful fulfillment.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Fairbanks
ALASKA
Kodiak
Sitka
Unalaska
PACIFIC
OCEAN
CANADA
Bremerton
McChord
Tongue Point
Hamilton
McClellan
Ogden
Alameda
Moffett
Lowry
Ft. Riley
Omaha
Sherman
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Quonset Point
Floyd Bennett
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Maxwell
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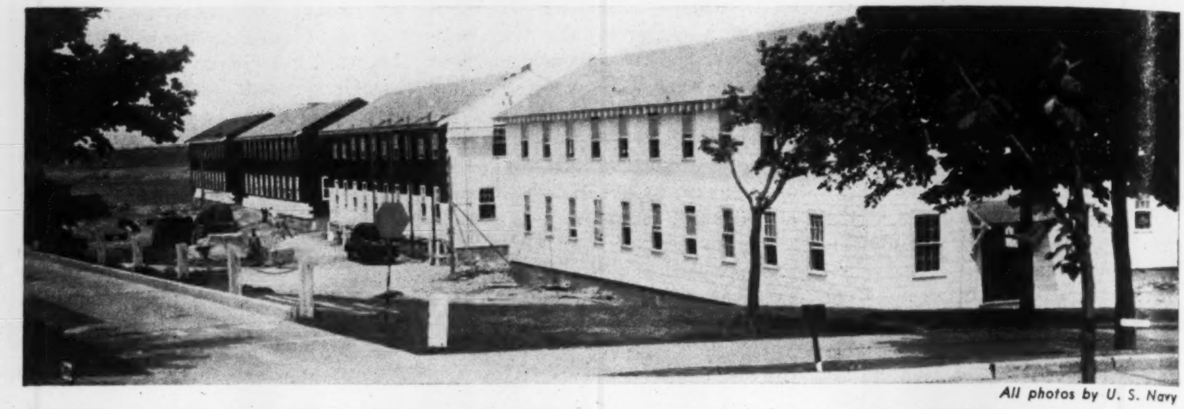
SOUTH AMERICA
Midway
Kaneohe Bay
Hickam
Pearl Harbor
HAWAII
Johnston
● Navy Airbases
○ Army Airbases
● Bases in British Possessions

Where our great air fleets will be based and serviced. Over 300 millions is being spent on new and augmented facilities.



All photos by U. S. Navy

Officially tagged "temporary", these barracks have the appearance and design commonly associated with permanency.

Navy Goes into Action on Housing

Contents in Brief—*Barracks for embryo sailors at Newport training station not only look like a model housing development but use the design advances and new materials that are commonly associated with such communities. Furthermore, their rapid construction, employing prefabrication at the site and extensive use of power tools, sets a mark for other contractors to shoot at.*

OF THE MANY KINDS of structures built as a part of our World War effort none is remembered more widely nor more vividly than the temporary barracks that were hastily thrown up to house the increased army and navy personnel. Because in a good many instances the memory is a painful one, in so far as design and construction are concerned, a common question has been: Can we or will we do any better this time? Stated in another way, will the temporary barracks of 1940 reflect the technological improvements that two decades of building development have given us?

At its training station at Newport, R. I., the Navy provides a dramatically affirmative answer in new quarters for about 1,000 enlisted men. Officially they are styled "temporary barracks", but a list of some of their features reads better than that for many a modern model house. Built for less than 34c. per cu.ft., including grading, utilities and all equipment, the facilities include barracks, mess halls and recreation room and reflect great credit on the Navy's Bureau of Yards and Docks and its Civil Engineer Corps personnel. And not only does the design erase any doubts of progress but the first of the barracks were in use 60 days after ground was broken, and the entire layout was completed 15 days later.

The layout consists of four two-story H-shaped barracks buildings and a single-story mess hall and recreation building known as a subsistence building, consisting of a central section with wings at right angles to it. There are four dormitories in a barracks building, two on each floor, located in the legs of the H, which are 100 ft. long and 28 ft. wide; a central row of columns divides each leg into two 14-ft. bays. Each dormitory accommodates 58 men in double deck bunks or in hammocks. The crossarm of the H, 28 ft. wide and 112 ft. long, is the service section. Along one side of a 4½-ft. corridor that runs the length of this section is a lavatory room (16 washbasins for 58 men), a toilet room (6 toilets), a shower room and a scrub room where 9 men at a time can wash their clothes. Across the corridor from the scrub room is the drying room, and the remainder of this side of the building contains a stairwell and the officers' quarters. No columns are used in the crossarm, the corridor walls serving as interior supports.

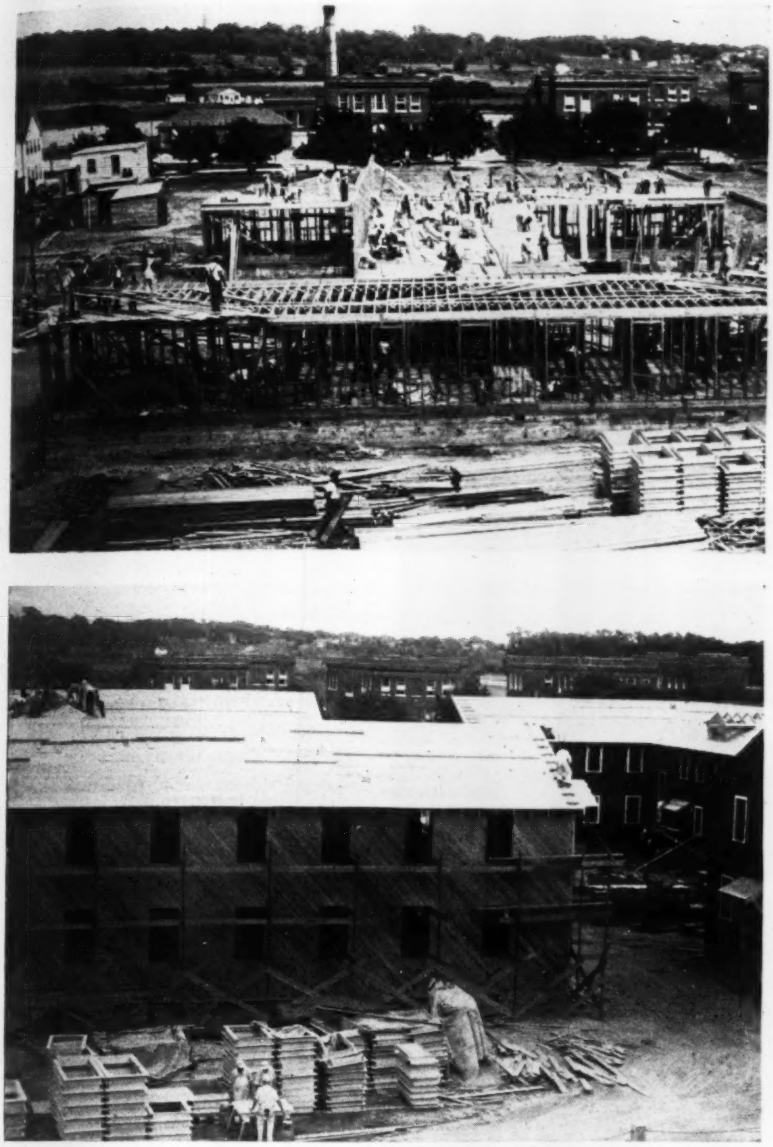
The subsistence building is symmetrical about the galley, located in the center of the central or utility section. Food is stored in a wing off the galley while the other wings, except for one used as a recreation room, accommodate the mess halls. The cafeterias are placed at the intersections of the utility section and the mess hall wings, and next to each cafeteria is a scullery.

Structure design

All barracks foundations, consisting of exterior walls, one line of piers along the centerline of each leg of the H and two lines of piers in the crossarm are poured concrete, extending 3 ft. below and 3 ft. above grade. The two lines of piers in the crossarm support the corridor walls and were also used to permit shortening the floor joist spans in this utility section of the building where heavy concrete floors are used. Screened vents are provided in the foundation walls to assure underfloor ventilation.

Sills are 4x6 in., while the timber beams that span between the piers are 6x12 in. in the living section and 8x12 in. in the utility section. Joists are 2x10's, 16 in. on centers, with 1x4-in. bridging. Flooring consists of a 1x6-in. diagonal subfloor covered with asphalt-saturated felt and 1x4-in. T&G wearing surface.

All studs are 2x4's on 16-in. centers. Roof rafters, set on a 1: 4 pitch, are 2x10's on 24-in. centers and frame into a 2x10-in. ridge member. Roof sheathing is 1x6-in. T&G lumber



Two stages in the growth of a barracks building. At the top specialist gangs of carpenters keep all parts of the building going up simultaneously. Bottom, a week later, enclosure complete, ready for roof, siding and window frames.

which is covered with green, mineral-surface asphalt shingles. Screened louvres are used in the gable ends of the roofs and in dormers placed along the sloping roofs, to assure ventilation. In the dormitory section the central row of columns is of 6x6-in. posts in both the first and second stories. Ceiling height of the first story is 9 ft. 2 in., of the second 9 ft. 1 in. First and second floor framing are identical.

Construction of the subsistence building is similar to that in the barracks except for the roofs which are framed with 32-ft.-span bolted trusses placed 2 ft. on centers. Also the building is only one-story. The ceiling height of the subsistence building is 13 ft.

The same type of wall enclosure is used in all of the buildings. On the exterior, diagonal sheathing is covered by building paper and cement-asbestos shingles. Interior surface is $\frac{3}{16}$-in. hard fiberboard painted egg-shell white, and the wall space is filled with 2-in. mineral wool bats. For the ceiling $\frac{3}{8}$-in. gypsum plaster-board is used to give a degree of soundproofing. Mineral wool bats also insulate the ceiling.

A deviation from this general type of construction is used in the utility section of the barracks where moisture is prevalent. Here floors are of concrete, 4 in. thick and placed on a timber subfloor covered with asphalt-saturated felt. The concrete slab is turned up at the walls to form the baseboard. In the subsistence building the floors are concrete, 5 in. thick, placed on soil fill. All pipes and grease traps are in covered concrete trenches in this concrete slab.

Walls in these sections are also made moisture-resistant. First sheathed in $\frac{3}{16}$-in. hard fiberboard, as in the other parts of the building, the walls are then covered with asphalt-saturated felt and cement-asbestos board. The shower room walls are of dense cement plaster.

Windows are of wood, of double-hung type operated by a spring-balance device that eliminates sash weights. Door hardware is brass, and brass pipe is used for the hot water system. All other piping, including that for both the fresh and salt water fire systems, is galvanized iron. Toilet fixtures are porcelain. An iron radiator is placed beneath each window in the barracks, but in the mess halls air unit heaters are used, suspended from the ceiling.

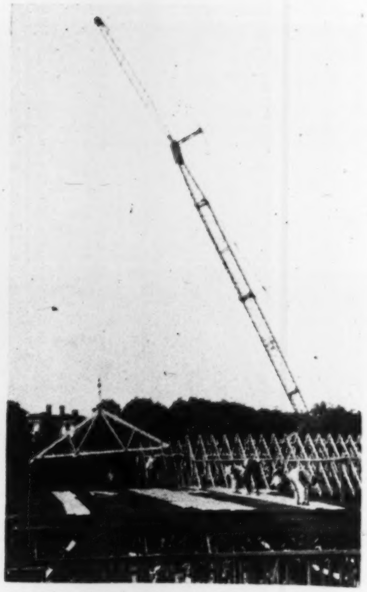
A specialty that will not be found in other military barracks is provision for swinging hammocks between the walls and the central row of columns. The studs not being designed to take the required horizontal loads, separate 4x4 posts were installed in the walls to provide for hammock attachment. At the columns resistance to the horizontal pull is furnished by kneebraces at the ceiling line.

Construction

Three months was the time agreed upon to build this modern barracks and mess hall layout. Sixty days after breaking ground recruits moved into the first building, and successive units were occupied at one-week intervals thereafter. Since building this 1,000-man village required a 2½-ft. fill over the entire site, the placing of all utility pipes and power lines underground in concrete trenches, the digging and concreting of the foundations and the erecting of modern buildings to inclose nearly 1,500,000 cu.ft. of space, the task was one that required careful planning and organization. Prefabrication of some elements and the extensive use of power tools and equipment also played a vital part in the result achieved.

As a beginning, the contractor's basic organization was expanded by

Key to fast construction was the prefabricating "mill" set up at the site. Beyond the pipe shop in the foreground, table saws and other power tools fashion every piece to size and shape. In background finished roof trusses are stacked.



Prefabricated trusses for mess hall roof were set by a long-boom crane.

taking in a number of subcontractors who were paid a salary to supervise purchasing in their specialties and to manage the necessary field work as assistant superintendents. Key material was lumber, of which nearly 1,000,000 b.ft. was needed, so that, simultaneous with start of grading operations, the lumber was ordered, scheduled off, and a site laid out for a field mill where cutting to length and prefabrication could be done.

For excavating utility and foundation trenches, five crawler cranes equipped with pullshovels were moved to the job. So rapidly did these machines work, backed up by numerous gangs of carpenters and concrete laborers, that forms were built, foundations poured and the work backfilled within 10 days.

The lumber, all of which had been delivered to the job 4 days after work started, was piled in different parts of the "mill" according to intended use. Mill equipment consisted of a 5-hp. electric table saw with rollers and a 12-in. electric table-saw with a lever arm attachment, both located in an open-sided shed, and supplemented by about 22 electric hand saws, 10 electric drills and other miscellaneous power equipment. In this mill all the sills and girders were framed in mortise and tenon, the floor joists and studs cut to correct lengths, the roof rafters, hips and valleys cut both to length and bevel, and the 32-ft.-span roof trusses completely pre-assembled.

Trucks were used to transport the lumber from the "mill" to the various buildings. There a crane with 110-ft. boom was used to transfer the lumber to its proper location, including lifting it to the second floor level. The crane was also used to erect the prefabricated roof trusses over the subsistence building.

A novel operation was the anchoring of the sills to the foundations while the latter were being poured. Thus, a sill with all anchor bolts in place was brought from the mill as a foundation wall neared completion and pushed down into the wet concrete to proper elevation.

Side wall framing of studs and braces (including the framing of window and door openings) for the first story were assembled on the first floor surface in sections about 50 ft. long, then raised into position on the sills. Temporarily braced to the first floor surface until the second floor framing could be erected, these walls were put up in record time. After the first story framing was installed the second story framing was assembled on the second floor surface in much the same way as for the first story.

Aside from these items of prefabrication, the speed of the job was due to the use of as large a number of workmen as it was possible to use on each particular operation. One of the essential factors in developing this speed was the use of separate crews of men under competent foremen for specific operations. In a general sense, this might be considered as the application of "assembly line" methods in the construction field. At the peak of the job some 500 men were employed.

Inasmuch as electric wiring was installed early on the job, such electrical hand tools as mortisers, sanders, saws, drills, groovers, etc., were used in the installation of all the finish material including the interior wall boards. This also speeded up the work. All the finish material such as door and window casings and headers, window stools, aprons, and staff beads, were cut to size and detail on the electric saw tables, groovers, and drills previously mentioned, and stacked in separate piles to be later merely nailed into place without any additional hand-sawing. This electrical machinery also turned out on the premises practically all the wood equipment and fixtures such as toilet partitions, rifle-racks, scrub-decks, cook's tables, breadboxes, fire extinguishers and cabinets.

The job was carried out under the direction of the Public Works Officer of the station, Lt. Comdr. R. E. Bassler (CEC), U. S. Navy, who succeeded Comdr. R. V. Miller (CEC), U. S. Navy, now in charge of the Quonset airbase, shortly after the barracks work started. The contractor was the Platt Contracting Co., Cambridge, Mass.; David Platt, general manager; Jack Platt, chief engineer; and Samuel Baker, general superintendent.

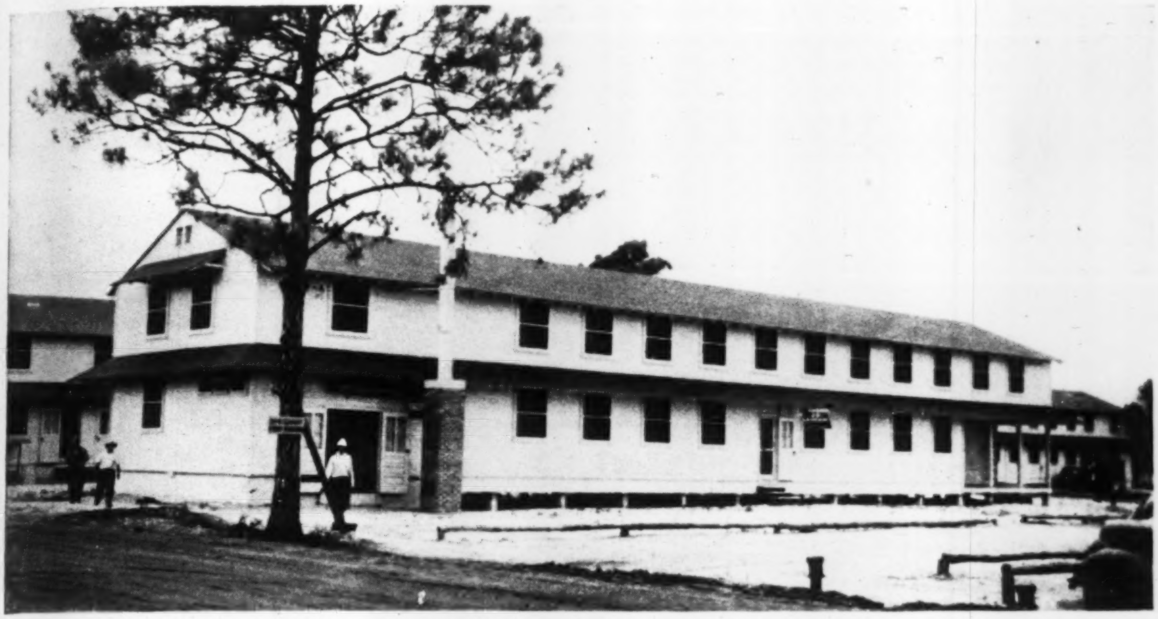


Fig. 1. Wood frame barracks, similar to this one at MacDill Field, will house most of our new Army.

Housing the New Army

Contents in Brief— *A score of towns to house 10,000 to 25,000 men each are being built at high speed for the new army of regulars, national guard and citizens in training. Wood-frame-and-sheathing construction is standard. Arrangement is in half-company two-story barracks units grouped in company and regiment array. Details are adapted to three temperature zones. Some camps have canvas-roofed structures or framed tents in place of wood-sheathed barracks. All construction is being rushed, on 90-day schedule. Typical of wood camp construction is Fort Dix where more than 900 buildings and the camp utilities are being constructed at a cost of $7,500,000.*

MODERN VERSION of the cantonment construction of World War days, camps are being built for the new army and the citizen trainees soon to be called out. Work is proceeding at high speed, in order that effective service training may get under way as soon as possible. These camps are in every way modern; the rough barracks of 20 years ago are giving way to buildings whose careful layout and up-to-date equipment approaches the standards of first-class home construction.

Camps are being built at army posts, on old cantonment sites, and in new locations. Considerations in site selection, aside from those of geographical distribution, are nearness to transportation, to city supply centers and to the quarters of regular army troops, who are to be used in training guardsmen and recruits.

Cantonment sizes vary over a wide range, according to local requirements. Where quarters for new enlistments in the regular army—recently increased by Congressional direction from 227,000 to 375,000—are required, the newly added sections are designed for only a few regiments, in some cases only 1,000 men; national guard and training cantonments, in most instances, are planned to accommodate one or two divisions, or 10,000 to 25,000 men, though with considerable variation according to the requirements of the particular branch of service involved. Other differences in camp arrangement depend on whether the forces to be housed are "square" divisions of 4 brigades or "triangular" divisions of 3 brigades. Camps for Air Corps personnel have requirements of their own, because of the special organization of this branch of the government service.

Wood structures standard

With few exceptions the cantonments are being built of wood, this material lending itself to greatest speed in procurement and labor supply. Essentially the designs and construction methods are patterned on the practices of normal house building. Chief departure is the use of composition roofing and wallboard. Some of the southern cantonments, and some temporary quarters at a few of the northern camps, have "framed tents" instead of wooden buildings, these being canvas roofs on wood floors and half siding.

As to layout, the camp buildings are arranged in company groups, with an individual barracks building for 63 men or half a company. Five buildings make the initial company group—two barracks, a mess hall, a storehouse, and a recreation building. Room is left for a third barracks building to be added later to bring the company up to war strength. Company units in turn are placed to form a regiment group, which includes (in addition to the company buildings) a headquarters administration building, hospital, barracks for the headquarters company, regimental cold storage building, truck garage and fire house. Regimental groups are separated from each other by 250-ft. open strips as fire breaks.

Equipment and layout

Utilities are provided in the cantonments as fully as in any modern city. Water is piped to every building, a sewerage system and sewage disposal plant are provided, and all buildings have electric light and power service. Heating units are for individual buildings except in the hospital groups. Modern plumbing—lavatories, shower baths, flush toilets and kitchen sinks—is matched by mechanical kitchen equipment in the mess halls. With the same objective of livability and comfort, windows are fully screened, and a wide rain-shield belt extends over each line of windows. For fire safety, the second floor of each barracks building opens at one end on a balcony served by a ladder fire escape.

The barracks buildings are laid out in open dormitories, but with rooms for the non-commissioned officers. The space allocation is 700 cu.ft. per man. Sleeping equipment consists of single-level steel cots with spring and mattress, 2 ft. 9 in. by 6 ft. 6 in., a trunk 18x33 in. placed at one end of the cot, and a steel locker 18 in. square by 7 ft. high at the other end.

Barracks buildings are 29½ ft. by 80 ft., two stories high. Mess hall, storehouse and recreation buildings are 25 ft. 4 in. wide, one story high. In the barracks building, the heater room and wash and toilet rooms are placed at one end of the building, on a concrete slab laid directly on the ground. The heater flue goes to a chimney set some 4 ft. out from the side of the building, brick in the lower part, steel smoke pipe thence to above roof level. Heating units are adapted to the most readily available local fuel, bituminous, anthracite or gas. Air heaters with fan circulation are standard, distribution being by overhead ducts with regulating dampers on all laterals.

Water is taken from a local community system if such is available; otherwise a supply is developed especially for the camp. Hydrants are set on the camp main for fire service, to be used generally in connection with a fire pumper, one of which is provided for each regiment.

Except where an existing army-post sewer system is available nearby, a main sewer outfall and a treatment plant are included in the cantonment works. The degree of treatment depends on the local stream conditions.

All cantonment buildings are set on concrete posts, which carry the sills and columns. With a view to order and appearance, the space between posts under the first floor is enclosed by wooden skirting.

Barracks framing, which is typical, comprises sills of three 2x8's spiked together, interior posts spaced 10 ft. each way, 2x4 studs with 4x4 corner posts on 24-in. spacing, transverse floor joists 2x8 in. on 20-in. spacing for the first floor, 2x10 in. on 24-in. spacing for the second floor, and 2x6 rafters on 36-in. spacing for the roof, the rafters being supported by the interior posts.

WHAT THE CAMPS INCLUDE

Tent Camp

Floors and framing for:
- 4057 pyramidal tents
- 522 wall tents
- 1 theater tent

Frame construction for:
- 16 administration buildings
- 125 enlisted men's mess
- 11 officers' mess
- 120 enlisted men's lavatories
- 19 lavatories for officers
- 17 motor repair shops
- 29 warehouses
- 12 post exchanges
- 10 recreation buildings
- 9 infirmaries
- 28 hospital ward buildings
- 6 medical detachment barracks
- 4 nurse quarters
- 2 clinic buildings

Note: The above facilities accommodate one division, cost about $5,000,000, including clearing, grading, railroads, roads and walks, water, sewers, electricity and telephones, as well as fire stations, laundry, bakery, magazines, etc.

Northern Type Cantonment

- 316 barracks (63 men each)
- 124 mess halls (170 men each)
- 130 storehouses (company)
- 130 day rooms (recreation)
- 4 officers' quarters (individual)
- 24 officers' quarters (barracks)
- 12 officers' messes
- 15 administration buildings
- 2 theaters (1,000 seats each)
- 3 fire stations
- 11 guard houses
- 12 post exchanges
- 9 recreation buildings
- 16 warehouses
- 17 motor repair shops
- 9 infirmaries

Note: The above facilities, plus hospital and miscellaneous buildings similar to the tent camp, include accommodations for 19,000 men and cost about $8,000,000 of which about $1,000,000 is for utilities.

Reception Center (1,000 men)

- 20 standard barracks
- 8 miscellaneous buildings
- 1 cafeteria

Note: Cost is about $275,000 including utilities.

Enclosure is ¾-in. dressed inner sheathing, building paper, and drop siding or plywood. The roofs are covered with bituminous roll roofing on sheathing. Floors are straight-grain fir on ¾-in. underfloor with building paper between. In the colder zones the walls are lined, or both lined and insulated; gypsum or fiber wallboard lining is used.

Mess halls and other company buildings are single-story structures with simple trusses formed by collar beams and knee braces to the rafters. One end of the mess hall is developed into an adequately equipped kitchen, with concrete hearth floor for the ranges, and a storeroom adjoining. This storeroom is supplied direct from the regimental warehouse and cold storage building. No food supplies are kept in the company storehouse, which is confined to general company supplies other than food.

Framed tents

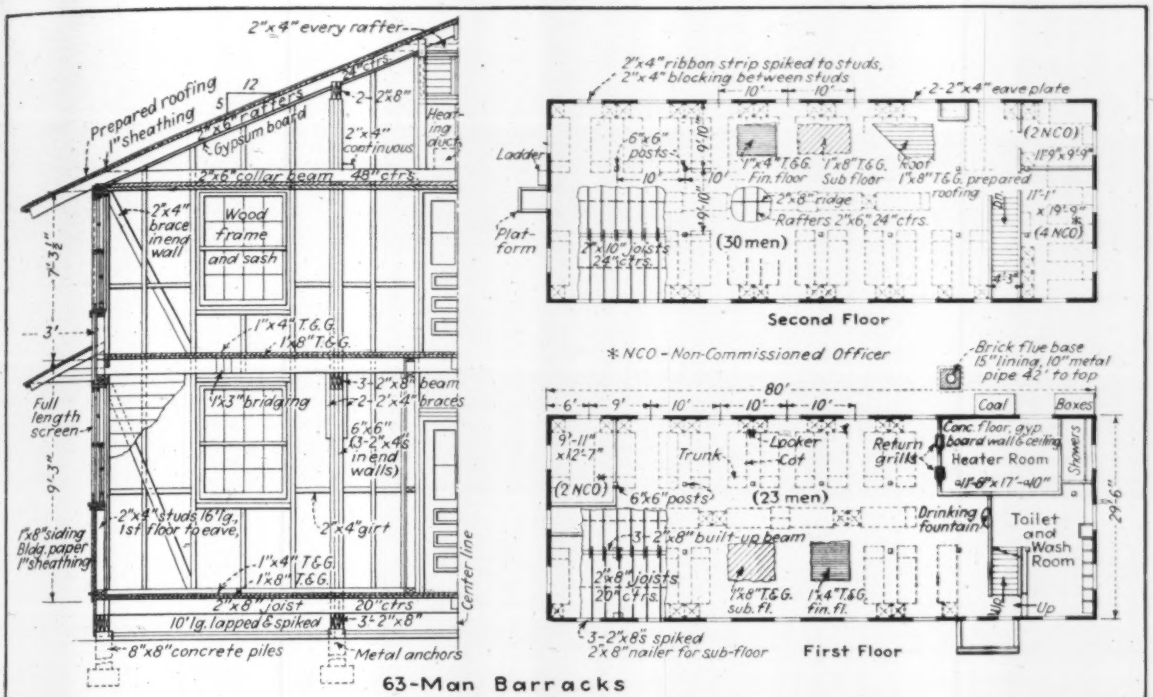
Rapid expansion of the military and training establishments, coupled with delay in voting funds to build substantial barracks housing of the type just described promptly enough, made it necessary to house a considerable number of troops in tent camps for a time, mainly in the southern latitudes. These camps comprise individual 8-man tents arranged in rows in a square accommodating one battalion.

The tents are a development of the simple platform tent by the addition of wooden side walls 5 ft. high, surmounted by a square tent supported by a center pole. Wash and toilet facilities are provided by four latrines occupying the four corners of the battalion square. Heating is supplied in some camps in the northern states by a stove in each tent. Camp streets are lighted by electricity.

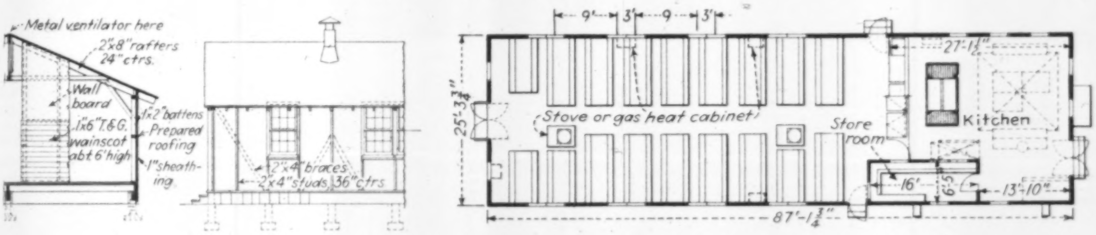
Progressive replacement of the tent housing by barracks of the general construction described above is planned. Wash and toilet facilities are not contemplated for these barracks, but the battalion washrooms will be retained in use.

How Dix is being built

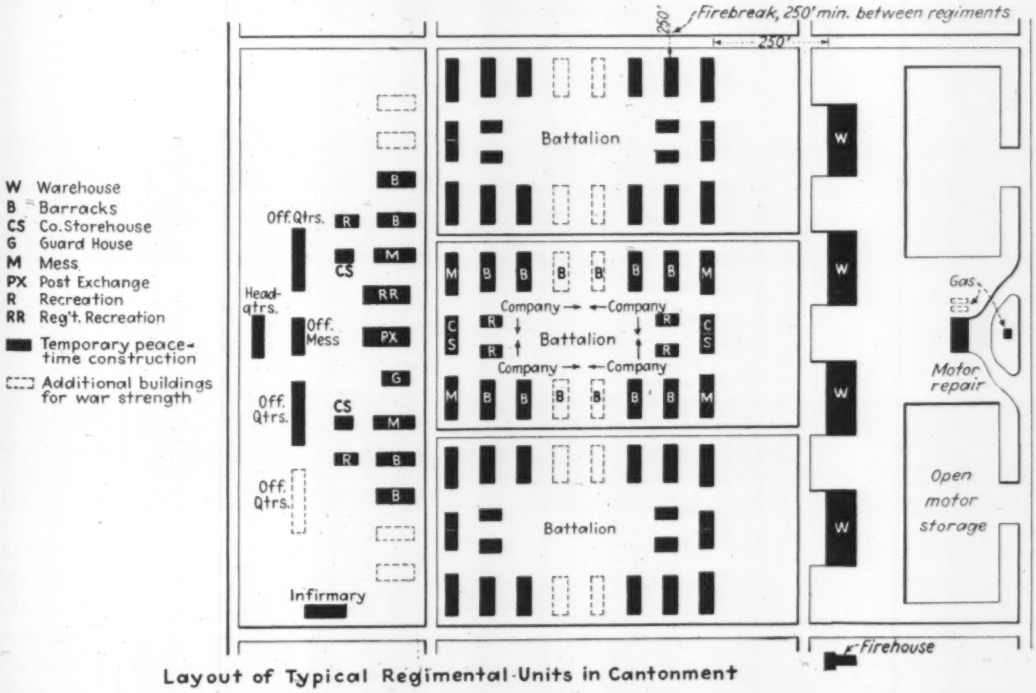
Probably typical of barracks construction is that at Fort Dix, N. J. which will serve as a reception and training center for the 2nd Army Corps Area consisting of New York, New Jersey, and Delaware.


2"x4" every rafter
Prepared roofing
1" sheathing
12
5
2"x6" rafters
Gypsum board
24" ctrs.
2-2"x8"
2"x4" continuous
Heating duct
2"x6" collar beam 48" ctrs.
2"x4" brace in end wall
Wood frame and sash
7'-3½"
3'
1"x4" T.&G.
1"x8" T.&G.
3-2"x8" beam
2-2'x4" braces
1"x3" bridging
6"x6" (3-2"x4's in end walls)
Full length screen
9'-3"
2"x4" studs 16' lg., 1st floor to eave,
2"x4" girt
1"x8" siding Bldg. paper 1" sheathing
1"x4" T.&G.
1"x8" T.&G.
2"x8" joist
20" ctrs
10' lg. lapped & spiked
3-2"x8"
Center line
8"x8" concrete piles
Metal anchors
2"x4" ribbon strip spiked to studs, 2"x4" blocking between studs
10'
10'
2-2"x4" eave plate
Ladder
6"x6" posts
9'-10"
10'
10'
1"x4" T.&G. Fin. floor
1"x8" T.&G. Sub floor
Roof 1"x8" T.&G. prepared roofing
(2 NCO)
11'-9"x9'-9"
Platform
2"x8" ridge
Rafters 2"x6", 24" ctrs.
9'-10"
2"x10" joists 24" ctrs.
(30 men)
11'-1" x 19'-9"
(4 NCO)
4'-3"
Second Floor
* NCO - Non-Commissioned Officer
Brick flue base 15" lining, 10" metal pipe 42' to top
80'
6'
9'
10'
10'
10'
Coal
Boxes
9'-11" x 12'-7"
Trunk
Locker
Cot
Return grills
Conc. floor, gyp board wall & ceiling
Heater Room
11'-6" x 17'-10"
Showers
29'-6"
(2 NCO)
6"x6" posts
(23 men)
Drinking fountain
Toilet and Wash Room
3-2"x8" built-up beam
2"x8" joists 20" ctrs.
1"x8" T.&G. sub. fl.
1"x4" T.&G. fin. fl.
Up
Up
3-2"x8's spiked 2"x8" nailer for sub-floor
First Floor

63-Man Barracks


Metal ventilator here
2"x8" rafters 24" ctrs.
Wall board
1"x6" T.&G. wainscot abt 6' high
1"x2" battens
Prepared roofing
1" sheathing
2"x4" braces
2"x4" studs 36" ctrs
9'
3'
9
3'
25'-3¾"
Stove or gas heat cabinet
Store room
27'-1½"
Kitchen
16'
6'-5"
13'-10"
87'-1¾"

Mess Hall for 170 Men


Firebreak, 250' min. between regiments
250'
250'
W Warehouse
B Barracks
CS Co. Storehouse
G Guard House
M Mess
PX Post Exchange
R Recreation
RR Reg't. Recreation
Temporary peace-time construction
Additional buildings for war strength
Battalion
Off. Qtrs.
B
R
B
CS
M
RR
Head-qtrs.
Off. Mess
PX
G
Off. Qtrs.
CS
M
R
B
B
Off. Qtrs.
Infirmary
M B B B B B B M
C S
Company
Company
R
R
Battalion
R
R
C S
Company
Company
M B B B B B B M
Battalion
W
W
W
W
Gas
Motor repair
Open motor storage
Firehouse

Layout of Typical Regimental Units in Cantonment

Fig. 2. Barracks for 63 men, one-third of a war strength company, and mess halls for 170 are the basic units of most camps.

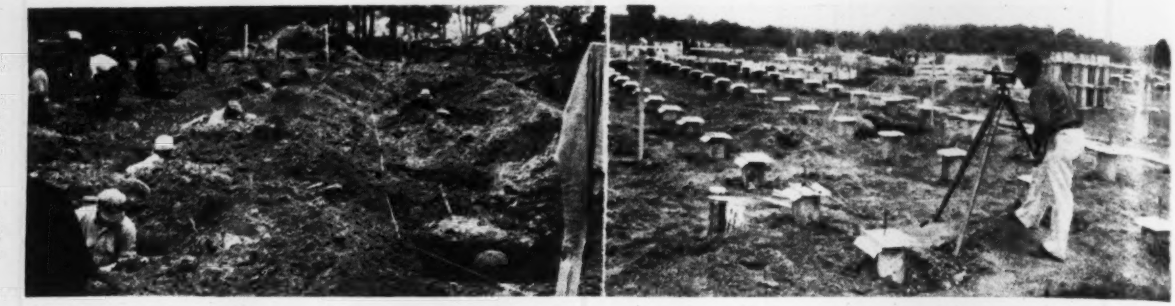


Fig. 3. Sand clay at Fort Dix stands without shoring even where man digs himself out of sight. (Right) Foundations are metal-capped concrete columns on spread footings, carried below frost line.

First class northern type barracks are being constructed to accommodate 18,000 men in a "square" division, consisting for the present of two infantry and one field artillery brigade and one brigade of special troops. A 1,000-man recruit reception center in a distant area is a separate unit of the camp. First tenants are expected to be the 44th Division from the New Jersey National Guard, 12,000 of whom are now in tents on the reservation.

Camp layout

The camp is laid out in regimental squares consisting of 3 battalions of 4 companies each as shown in Fig. 2. Two such regimental units make up the brigade which forms one of the major divisions of the camp. Construction follows the description given for northern type barracks, with a variation from the standard described of 3 barracks being built now for each company to accommodate the full war strength in nearly all battalion areas.

Principal construction, consisting of 862 buildings, divided about as outlined on p. 44 is being done by the George A. Fuller Co. of Philadelphia and New York, under a $5,531,000 contract obtained by competitive bidding. Two other bids for all of the work were received, 2½ and 12½ per cent respectively above that of the Fuller Company, and 6 additional firms bid on parts of the work. Award of the contract was made the date bids were received and the notice to begin work was dated two days later, Aug. 30, making completion date of the 90-calendar day contract Nov. 28. A later contract provides for hospital unit and utilities.

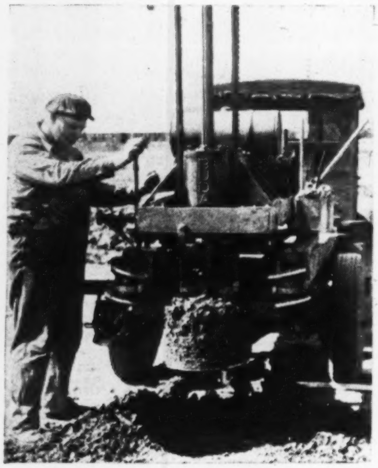


Fig. 4. Power-driven earth drill makes foundation excavation at Chanute Field.

To get the advantage of specialists in each line of construction subcontractors handle several of the phases of the work. Excavation, framing, heating and plumbing, and electrical work are done by organizations especially skilled in their respective lines. The general contractor handles all engineering, foundation, masonry and finish carpentry work and, of course, coordinates all activities.

For convenience in supervision, construction on the Fuller contract is divided into 6 separate sections staffed from the contractor's permament organization to handle the work in one area. Here a division superintendent has complete charge of the work done by the contractors' own forces and of the subcontractors working in the area. He has his own equipment and trucks, a separate carpenter yard and storehouse and calls on the central field office only for major supplies.

Engineering layout of the structures is the contractor's responsibility, the Constructing Quartermaster giving only control lines and elevations. Transit crews work in each area marking out the foundation on firmly set batter boards. A level party sets finished first floor level boards at each corner of a building and these are used for all elevations subsequently required by measuring down from this established control.

Most of the cantonment construction area is comparatively level with the building sill elevation established slightly above the average ground contour. All buildings are on concrete columns or walls on spread footings not less than 3 ft. below the final ground surface, to be below frost action. Walls are used where underfloor plumbing requires general excavation.

All excavation for columns is done by hand, the sand clay material standing without shoring for excavation as deep as 6 ft. The material digs easily, excavation size being determined by the minimum room required to shovel. Where excavation for plumbing is necessary to a depth of more than 2 ft. a clamshell-equipped crawler crane is used, which swings the material clear of the working area.

Columns up to 5 ft. high, are 8 in. square on 16x16-in. footings; those 6 to 9 ft. high are 10 in. square on 18x18-in. footings. Forms for the columns are all prefabricated of 1-in. S4S lumber; 2x3-in. collars with a hinge at one corner and a pin at the corner opposite are used on 16-in. centers.

The footing form, also made in advance using 1-in. lumber lightly nailed to permit easy stripping and reassembly, is tacked to the column and both are set and lined up at one time, a "grade nail", set by instrument, giving top column elevation.

Truck-mixed concrete

Concrete is about 1:2¾:4¼ mix using ¾-in. maximum size gravel or crushed stone, and is placed with a medium slump without use of vibration. Placing is entirely from buggies or barrows dumping directly into the forms.

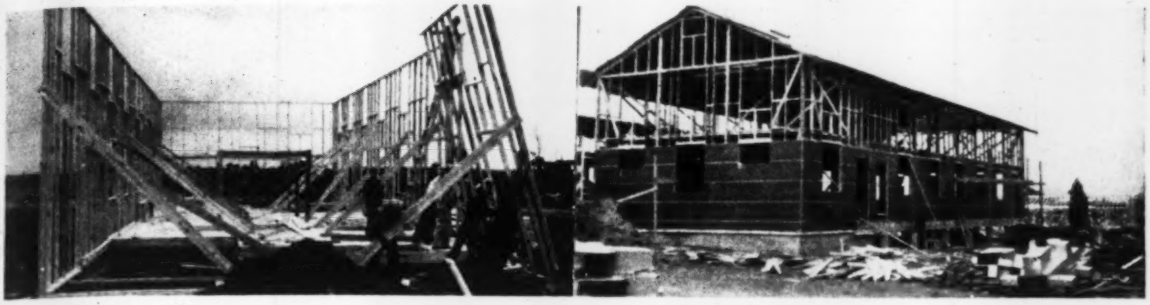


Fig. 5. Standard practice seems to be fabrication of the wall framing on the floor then raising to position as shown at Chanute Field (left). Dix uses gypsum insulating board over outside of studs followed by paper and drop siding.

Most of the concrete comes to the point of use by transit-mix 2 and 4-yd. trucks. A portable bin is set at a railroad siding outside the camp and sand and one size gravel handled to it by crawler crane. A third compartment, watertight, holds bulk cement, transferred from cars by a bucket elevator. Material, including water, is charged directly into the drum in 2-yd. batches and mixed in transit. The plant has been unable to supply the 700-yd. maximum daily requirement, so part of the concrete is mixed at point of use in 10 and 14-cu. ft. mixers, charged by wheelbarrows.

Lumber totals 32,000,000 ft.

Framing of the 862 buildings in the little more than 60 calendar days remaining after first foundations were available required unusual planning and as much prefabrication as possible. Because of the light material used, the only machines employed are table saws at the yards and portable circular saws powered by small gasoline-driven generators. As many of the buildings are exactly alike, 336 are 63-man barracks, the lumber for each can be accurately prepared in advance and all necessary pieces placed near point of use. Usual procedure is to move the saw to the lumber which is piled conveniently near its point of final placement as it comes from the cars.

Framing work is set up on a production line basis, i.e., the men on first floor framing do only that, then move on to the next building. Following the floor construction another group assembles and raises the wall frames, moving on to make way for the second floor crew who are followed by others to complete the work.

A basic carpenter crew consists of a foreman, 9 journeymen carpenters, 2 apprentices, and 2 laborers. A supervising foreman will handle 10 such groups working in one area. Plan for production is to complete 5 buildings per day in each of the 4 major areas. The recruit reception center has served as a carpenter training school with all buildings carried up together while awaiting working space in other areas. The 17 warehouses were completed at the rate of one a day after 4 days from the time foundations were available for the first building.

Grade-marked lumber

Much of the lumber in use is No. 2 common southern pine with fir making up most of the remainder. All lumber is grade-marked and structurally sound though the classification permits many defects.

The general construction follows closely that outlined above for standard barracks construction. Insulating board is substituted for the ¾-in. sheathing on the outside of the studs, this being covered by a layer of paper, then 1x8-in. drop siding nailed on.

Plumbing and heating in the buildings is done as the work progresses, starting as soon as the foundations are placed. Special crews for individual items are not presently planned, one gang doing all of the work below the floor and then returning to complete the installation when framing permits. Separate organizations install the sheet metal duct and the heater units.

Electrical work follows the framing, fitting in above the ceiling insulation for partial concealment. Working procedures are not developed as this is written, since only a few buildings are far enough along to give working space.

Sufficient labor available

Despite employment of nearly 2,600 men on contract work and more on work for the quartermaster direct during early October, no serious shortage of labor was apparent in the camp. Workmen appear to be able and cooperative, and fewer complaints are heard about those available than is usual under similar circumstances. Hiring on the site is handled through a union representative who sends satisfactory applicants to the contractor.

Personnel

For the George A. Fuller Co., D. P. Appell is in general charge with C. G. Woerner, manager of Fuller's Philadelphia office temporarily project manager in place of Tom Wiggins, on sick leave. H. W. Dobson is outside superintendent; A. O. Neil is office manager; and W. R. Crowell, chief estimator, is handling costs at the site. Principal subcontractors on Fuller's work: Foundations, Inc., Moorestown, N. J., excavation; Kingston Trap Rock Co., Kingston, N. J., concrete; Norcross Sand & Gravel Co., Pemberton, N. J., concrete material; John A. Johnson Co., New York, building framing; Lipskey and Rosenthal, Brooklyn, plumbing and heating; and Spitzer Electric Co., Brooklyn, electric wiring.

In addition to the Fuller contract the 700-bed hospital unit and the camp utilities are being constructed by La Fountain, Christensen and Arace of Hackensack and Elizabeth, N. J., for $1,713,400; the 1,000,000-gal. filter plant is being built by Karno-Smith Co. of Trenton, N. J., and the 8-and-10-in. water line is being laid by A. Stanley Mundy & Co. of Woodbridge, N. J.

Major John R. Tighe is constructing quartermaster in charge of the contract work, assisted by 1st Lieut. Robert A. Gaw and 1st Lieut. Milton Havens. C. Gilbert Countiss is chief engineer in charge of planning, design, and construction at the Fort Dix project.

U. S. Navy Photo

New barracks for the Navy are laid out to provide ample air, light and cross-ventilation.

Permanent Quarters for Defense Forces

EFFICIENT DEFENSE MEANS efficient men as well as guns, tanks and other fighting equipment. Efficient men, in turn, mean living quarters abreast of modern standards. Recognizing this, both Army and Navy in their present defense development are providing the armed forces with permanent quarters that combine safety, sanitation, convenience and comfort, together with all the attractiveness that skillful design satisfying the primary requirements will assure.

Barracks of modern character are replacing the old-time military housing. Much of the new construction is striking in its attractiveness, yet in no case were costs increased materially for architectural effect.

Quarters for enlisted men in the Army are planned on the basis of 700 cu. ft. per man. The Army favors large buildings. It has just completed a new barrack at Chanute Field, Illinois, that will house 2,200 men. The Navy on the other hand favors more units of less size.

Open dormitories are provided for the enlisted men, each accommodating a company, squadron or some similar unit, with separate rooms for non-commissioned officers, two or four to a room. Detached houses or apartments are provided for married officers and non-commissioned officers, and bachelor officers are provided with individual quarters in large buildings.

The character, form and orientation of buildings is determined largely by climatic conditions. Thus the army barrack at Hickam Field, Hawaii, is oriented to get maximum exposure to prevailing winds, and instead of windows it has continuous belts of screened openings. The Navy's barracks buildings at Pensacola are characterized by extensive use of screened porches two stories high.

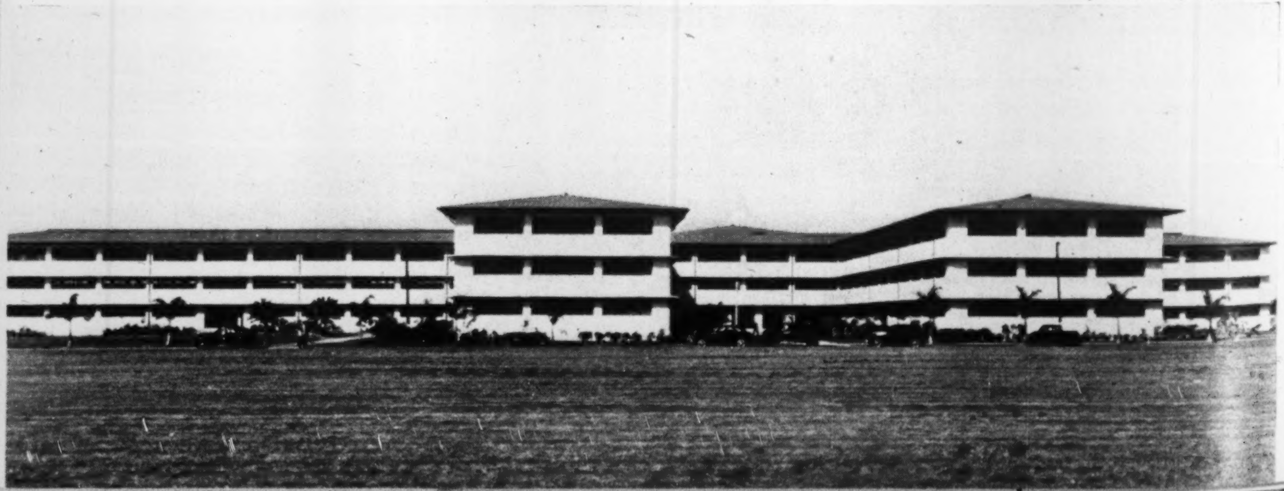
Architectural treatment is varied to meet climatic requirements or to be in harmony with prevailing local types. This in turn determines the type of construction. Little inflammable material is used, the only wood being in doors, windows and in the roof framing of some barracks. All construction is designed with an eye to keeping maintenance costs at a minimum.

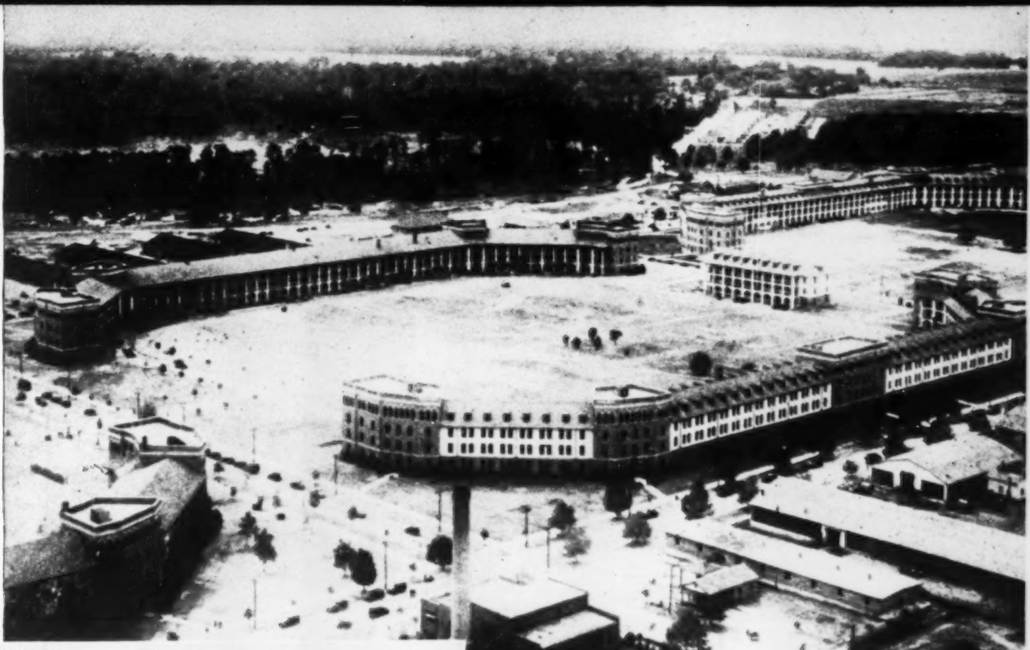
Construction types include both steel and reinforced concrete frame, with brick, tile or concrete walls and concrete floors. Pitched roofs are tile or slated-covered; flat roofs are built-up membrane. Wall types also are varied to suit climatic conditions, structural tile with glazed interior faces being used extensively in the south for exterior walls, while in the north the tile walls are furred and plastered. Ceramic tile is used extensively in washrooms and corridors. Linoleum is used widely as a floor covering, cemented to the concrete, but tile also is used. Acoustical plaster or tile on the ceilings of common rooms is found at some points.

At Pensacola, where moisture penetration through brick walls has always been a problem, the Navy has specified a type of wall construction designed to eliminate this difficulty. The walls now are built with a brick face and tile backing, the tile being so designed that the walls can be laid with no continuous mortar joints through the wall and with open spaces between the tiles or between brick and tile all connected so that any moisture getting through the brick will drain down between the tiles to the bottom of the wall to weep holes.

Belts of screened openings are used instead of windows in the Army barracks at Hickam Field, Hawaii.

Photo by U. S. Army Signal Corps

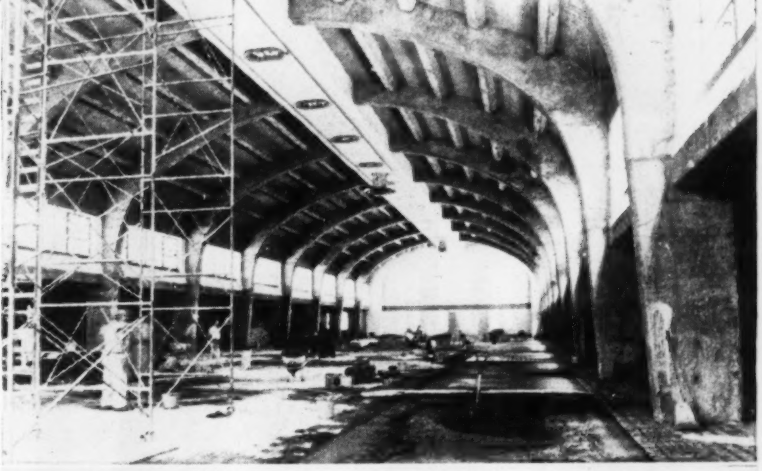




Wide-World Photo

The barracks at Fort Benning, Ga., are built on opposite sides of large open courts. (Left) Barracks at Naval air stations in the south are equipped with large screened porches opening directly from the dormitories.

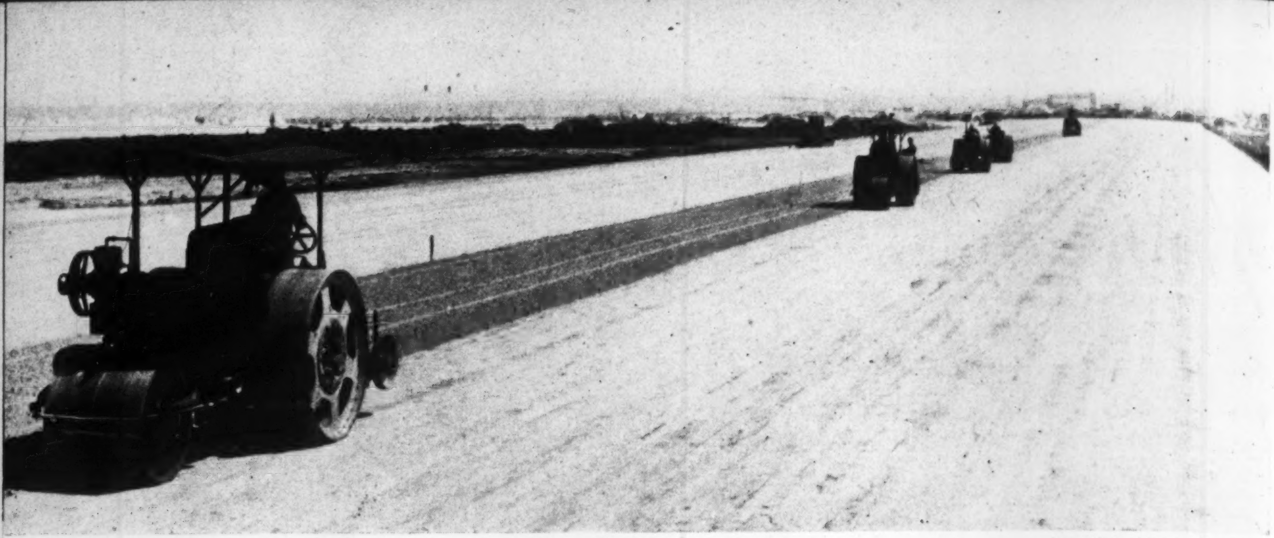
U. S. Navy Photo



The mess hall for the big barracks at Chanute Field is notable for its arched rigid-frame concrete roof construction of 60-ft. span and 32-ft. rise.

Interior of one of the three courts of the 2,200-man barracks at Chanute Field.

U. S. Army Air Corps Photo



Leo Witt, Jacksonville Journal

Rolling limerock surfacing on the 300-ft.-wide runways of the Navy airfield at Jacksonville.

Building Bases For Our Air Forces

Contents in Brief—*To assure adequate air defense for modern types of warfare, a farflung system of airfields and bases is being created by both Army and Navy. Part of the system is nearing completion, much of it is still under construction. Different types of stations are included, from school fields to operating fields. Facilities include runways of ample capacity, large modern hangars, quarters for personnel, repair and supply buildings, fuel storage tanks, magazines, and utilities.*

HUGE EXPANSION of the nation's defensive aviation facilities is being undertaken by both Navy and Army. The commanding place of aerial warfare made evident by European developments was first recognized by Congress in April, 1939, when it authorized the expenditure of $66,800,000 on Navy airbases, of which $36,400,000 was for bases in the Pacific. Before it adjourned in August, 1939, Congress appropriated $63,000,000 for Navy airbases and $62,000,000 for Army airbases. These appropriations inaugurated the expansion program, and work was underway before the end of 1939. Appropriations made this year have greatly expanded the work.

Two fundamentally distinct types of fields are required: tactical or operating fields and supply and repair depots. The Army Air Corps system of fields in the main has the supply depots separate from the tactical fields, while in the Navy they generally are combined in a single station. A third type of field is the school field for the training of flyers or mechanics.

The principal airbases are given in the table on page 352. Their construction calls for a wide variety of operations. In addition to the landing field and hangars a modern airbase requires great shops for the assembly and repair of airplanes, shops for the overhaul and testing of engines, warehouses for a multitude of supplies, magazines for storage of bombs, ammunition and detonators, photographic laboratories for the expeditious handling of air photographs, administration and control buildings, radio stations, power plants, fuel storage and distribution facilities, and housing and subsistence facilities for anywhere from five to ten thousand men, with the water supply and sanitary systems of a small city. There also must be rail and road service facilities, and at Navy stations, piers, bulkheads and seaplane ramps whose construction is usually accompanied by a large amount of dredging. Where facilities for training a large number of cadets or mechanics must be provided, as is the case at most stations, the housing and subsistence structures for these men must be added to that required for normal functioning of the base. At some stations this temporary increase will bring the population to 20,000.

To get a picture of the wide variety of construction operations involved in building these bases members of the editorial staff of *Engineering News-Record* visited a large number of them, selecting fields of different kinds and in different parts of the country. Among those covered were the fields at Chicopee Falls, Mass.; Quonset Point, R. I.; Jacksonville, Tampa, and Pensacola, Fla.; Mobile and Montgomery, Ala.; Corpus Christi, Texas; Rantoul, Ill.; Denver, Colo.; and Sacramento, Calif.

Of the Army bases visited, Westover Field at Chicopee Falls and MacDill Field at Tampa are entirely new tactical fields at which all the normal facilities must be provided. Tampa will have auxiliary training fields at Orlando and West Palm Beach. Lowry Field at Denver was established in 1937 as a school for gunnery, bombing, aerial photography and mapping, the Army having taken over and remodeled the buildings of an abandoned sanitarium.

Nine miles east of Denver an auxiliary field, some of whose runways will be 2 miles long, is being built for loading bombers and other hazardous operations. Maxwell Field at Montgomery is the Southeast Air Corps Training Center established during the World War. It is now being expanded to include the Advanced Flying School, the Montgomery municipal airport having been taken over as an auxiliary field, while new auxiliary fields are being built at Selma, Ala., and Valparaiso, Fla. McClellan Field at Sacramento is the major supply and overhaul depot for the Army on the Pacific Coast. Bates Field at Mobile is being developed into a similar depot to serve the Southeast, including Panama. Chanute Field at Rantoul, Ill., is a ground school for mechanics. Some weather observers will also be trained at this field.

The Navy's principal airbase for the Northeast area is to be the new station at Quonset, R. I., which will also serve as a repair station for carrier-based aircraft; the new base at Jacksonville will serve the Southeast, and will have an outlying seaplane base at Banana River and an outlying field at Green Cove Springs. Pensacola is the Navy's oldest air station and its chief air training center until the present expansion of facilities was begun. The main station at Pensacola is being enlarged, two outlying training centers, Corry Field and Saufley Field, have been built, and a third is projected. The Corpus Christi station is entirely new and is being built primarily for training purposes. It also will have two outlying training fields, and plans are being made for a third.

In type of structures required the two services vary little except that the Navy has to provide facilities for seaplanes at all its major stations and is equipping some stations to service aircraft carriers as well. Another factor tending to increase the size of the Navy base is the Navy's policy of decentralization of major repair operations.

Preparing the Airfield Site

Most airfield sites require a considerable amount of grading and at some bases this operation is a major element of the construction program.

Grading at Jacksonville

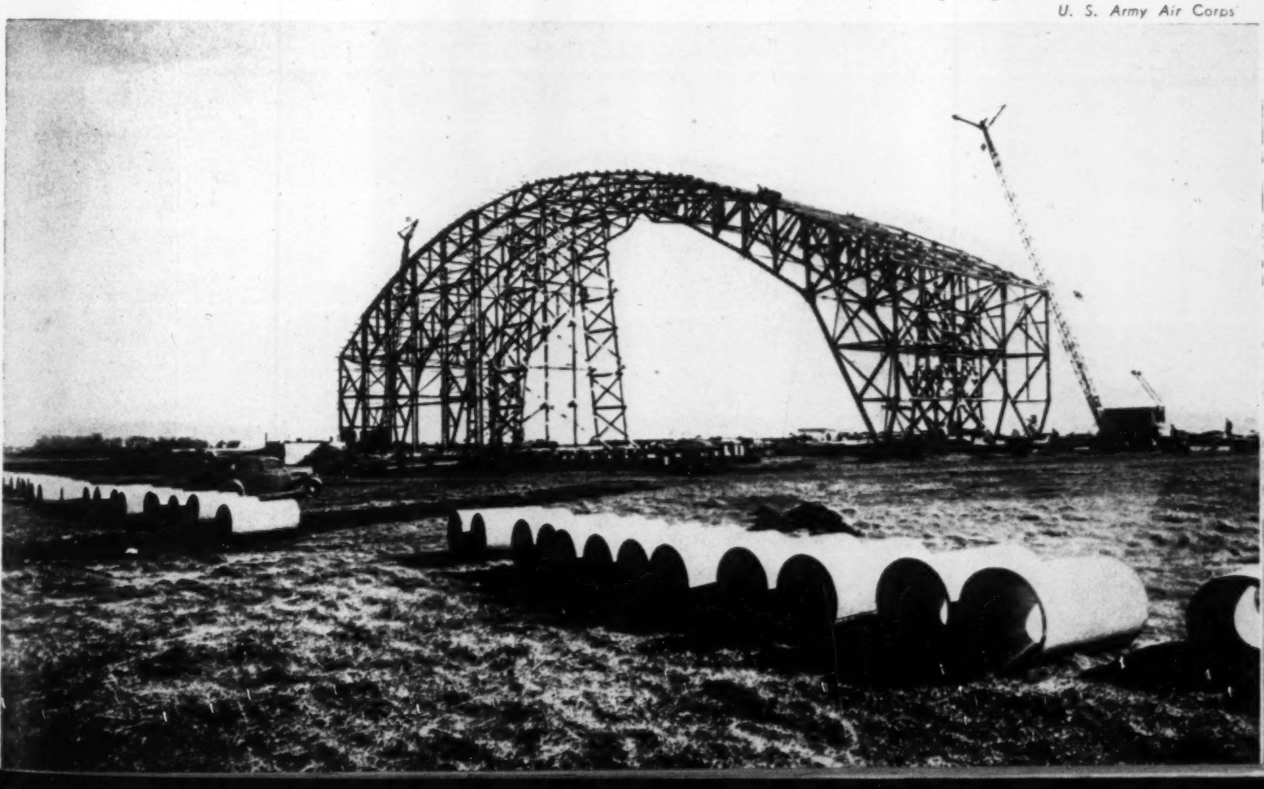
The grading operations at Jacksonville may be taken as typical of the large problem such work presents when time is an important factor. The site is on a relatively flat point at a bend in the St. John's River, part of which had been cleared and used as a camp during the World War. The area chosen for the landplane field lies to the north of the old camp. It is a rolling sand plain of about 550 acres with ridges up to 15 or 20 ft. above river level and cut by valleys filled with cypress swamps. The whole upland area was overgrown with pine and palmettos.

High groundwater and a very slow rate of percolation through the fine sandy soil following the almost daily showers of the late summer months complicated the earthmoving and promised to slow up consolidation of fills for the runways. To offset this condition, the first thing the contractor did was to cut deep drainage ditches back into the field along the natural drainage channels, with shallower ditches reaching to all areas needing to be drained. Culverts were put in where these ditches cut across runway zones and ultimately pipe for the permanent drainage system will be laid in these ditches.

Grubbing was done with heavy plows much like a highway snowplow with a cutter blade projecting from the lower edge of the plow. These plows, pushed along with the cutter below the surface, were followed by large farm cultivators and finally by hayrakes that pulled out the loosened roots. In the low areas the muck was

Setting the three-hinge arches of 275-ft. span that form the roof of a standard Army hangar.

U. S. Army Air Corps



bulldozed into windrows and picked up by draglines for disposal by truck.

When the grading operations reached their peak in September, eight 12 cu.yd. carrying scrapers were being used for earthmoving and one 5 cu.yd. machine for dressing. In addition, the work of grading and preparing the runway surfacing employed nine bulldozers, two leaning-wheel 12-ft. grading machines with tractors, four motor-patrol graders, three farm cultivators, three hayrakes, one logskidder and nine combination clamshell dragline machines. About 500,000 cu.yd. of sand and muck were moved.

The present contractor took over the clearing and grading early in July and is working to have a large part of the field ready by the first of December when cadets will begin to arrive for training. To that end the grading operations are being carried on continuously, three shifts a day. The paving, which will be described subsequently, is on a one-shift basis as it can keep up with the grading at that pace.

Clearing at Corpus Christi

A condition somewhat similar to that encountered at Jacksonville was found at Corpus Christi when clearing of the field was begun in July. After the mesquite that covered the field had been cut an attempt was made to get the roots out of the surface soil by pushing a blade through the ground about 8 in. below the surface. This did not work because the sand was so fine and so lacking in binder that the roots just pushed over and were not cut off. Now, deep disking is employed, and the roots are harrowed out and burned.

The fineness of the sand and its lack of cohesion also presented a difficult grading problem to the engineers and contractors. No heavy grading is required, but there is a large amount of shallow cutting and low filling that can be done with draglines and trucks. However, it was found that after the soil had been worked over to free it of roots it was so loose that trucks could not operate in it when it was dry. Consequently, in the program that has been worked out, trucks serving the draglines have to use temporary roads made by leveling the sand and sprinkling it. Sprinklers move over these roads periodically to keep them moist, in which condition the roads will carry the trucks. The draglines work parallel to the truck roads, and the roads are shifted as required. About 350,000 cu.yd. are being moved in this operation.

Of special note in connection with the grading of Saufley Field, one of the outlying training centers at Pensacola, is the fact that a shrinkage of nearly 50 per cent developed when the contractors began to work the soil. The field did not require a large amount of grading but considerable shallow cutting and low filling was necessary. When the contractor began the grading work the shrinkage was so large that shallow fills often were required when cuts were called for on the plans.

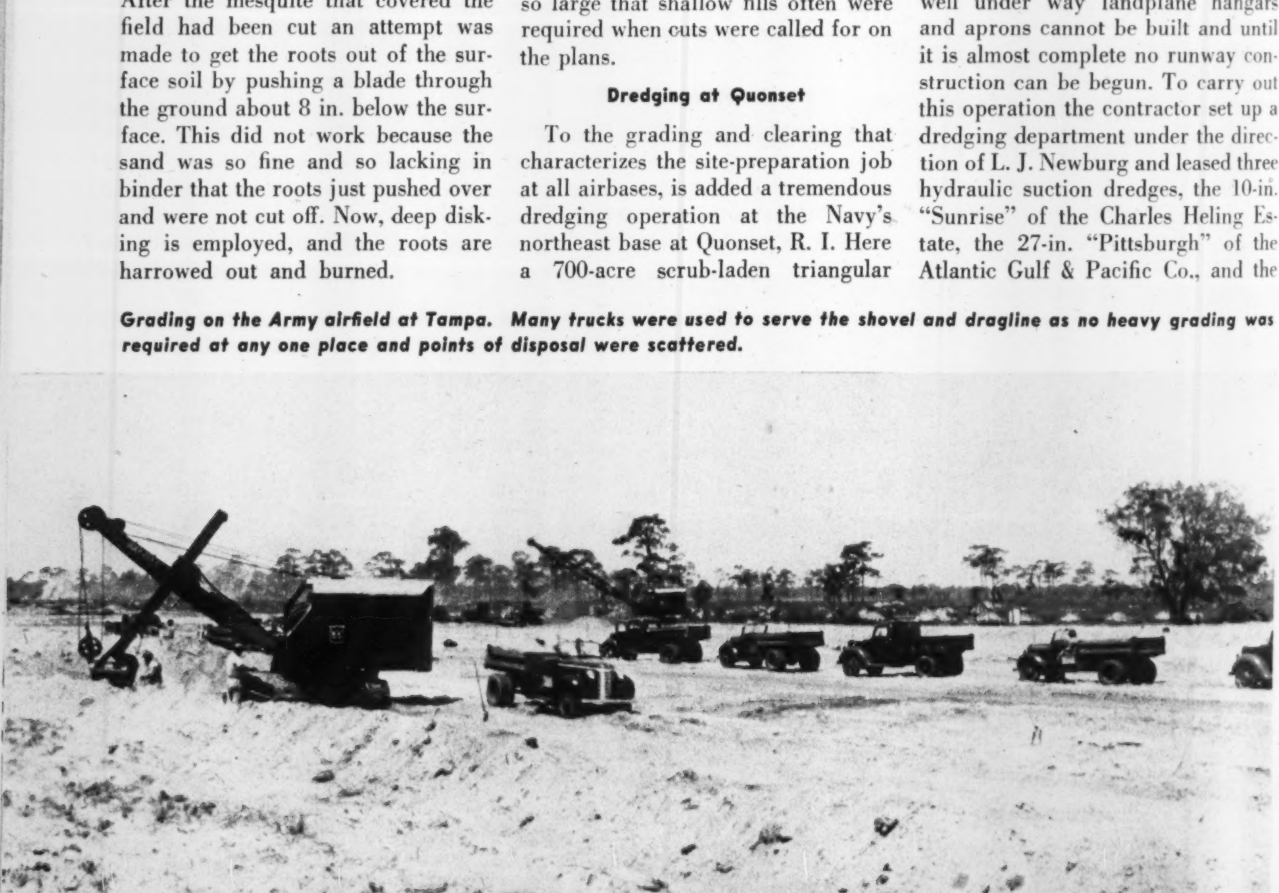
Dredging at Quonset

To the grading and clearing that characterizes the site-preparation job at all airbases, is added a tremendous dredging operation at the Navy's northeast base at Quonset, R. I. Here a 700-acre scrub-laden triangular point of land jutting into Narragansett Bay, about 12 miles above the mouth at Newport, is being converted into a square site of 1,000 acres by reclaiming 300 acres of the bay. Nearly 12,000,000 cu.yd. of hydraulic fill is required, two-thirds of which must be pumped between August and Christmas if the schedule is to be met. It is a job of magnitude, speed and careful planning.

Quonset will have a 1,000-ft. long pier on each side of which an aircraft carrier can dock in 35 ft. of water after coming in through a 3,000-ft. square turning basin also 35 ft. deep. This basin and the pier slips account for nearly 5 million yards of the required dredging; some 1,500,000 cu. yd. more must be pumped from the seaplane approach between the bulkhead and the 12 ft. low water contour, and another 400,000 yd. from a channel giving access to a protected harbor where small craft and crash boats can be berthed. Required dredging thus provides about half of the hydraulic fill needed. The remainder must be obtained from dredge cuts located as near the fill area as possible.

Principal reason for the rush schedule on the job is that the 300 acres of hydraulic fill will constitute the landing field. Until this operation is well under way landplane hangars and aprons cannot be built and until it is almost complete no runway construction can be begun. To carry out this operation the contractor set up a dredging department under the direction of L. J. Newburg and leased three hydraulic suction dredges, the 10-in. "Sunrise" of the Charles Heling Estate, the 27-in. "Pittsburgh" of the Atlantic Gulf & Pacific Co., and the

Grading on the Army airfield at Tampa. Many trucks were used to serve the shovel and dragline as no heavy grading was required at any one place and points of disposal were scattered.



26-in. "No. 5" of the Gahagan Construction Co.

To meet the schedule each of the two large dredges has to average 1,000,000 cu.yd. a month, so that the dredge cut areas were laid out to permit the use of minimum lengths of pipeline. A pipeline from each dredge was laid on pontoons to a point 300 ft. inshore from the bulkhead line where discharge commenced, the plan being for each dredge to build a berm to the shore over which the pipeline could be progressively laid until it reached the farthest inshore point of fill area. By leaving open water between the projecting berms, danger of trapping mud boils is eliminated. Filling between the berms will be from the shore outward so that the mud, if any, will be pushed ahead of the fill. The maximum length of pipeline contemplated is 11,000 ft., although the average length, and the one most generally used, will approximate 6,000 ft. Fill depth varies from 26 ft. at the bulkhead line to about 10 ft. at the inshore edge.

The dredges move back and forth in 270-ft. wide cut areas which are marked by buoys. The material dredged so far consists of about 60 per cent fine sand and 40 per cent coarse sand and boulders. Most of it has dredged easily although some deposits of cemented sand have been encountered which have cut down the output.

The dredges are working 24 hours a day 6 days a week, with Sunday reserved for necessary repairs. Progress at the current rate will complete the fill to within 300 ft. of the bulkhead line by Christmas. Dredging will then be interrupted until the bulkhead is completed so as not to encroach on the 10 ft. depth of water required along the bulkhead, which will be about 11,000 ft. long, of steel sheet piling. With completion of the bulkhead, dredging will be resumed behind it until the fill is brought to the grade of the flying field.

Landing Field Drainage Practice

Methods employed for draining the airfields vary widely. At Corpus Christi no system of underdrains is to be installed initially, this despite the fact that rainfall may be as high as 2 in. per hour. Studies made by the engineering staff indicate that the soil is so porous that it will absorb this heavy rain without large accumulation of surface water for any great length of time. However, in case longer experience shows drains to be necessary, pipe for a drainage system is being laid where the system would cross the runways to save disturbing them later.

In sharp contrast to the Corpus Christi field is Saufley Field, one of the auxiliary training fields for the Pensacola base. There, with a similarly high rate of rainfall, but with a natural runoff of 90 per cent for short storms, the drainage system is laid out for a runoff of 100 per cent. This is due in part to the non-porous nature of the soil but also to the fact that a large part of the field is being covered by runways and other paved areas at the present time and to the probability that the paved area will be increased in the near future. The field has a general east-west drainage axis with some drainage going in each major direction but with the larger part concentrated to the south. Generally, the drainage arrangement as laid out is for water to flow over the surface to shallow depressions between the runways where drop inlets with large cast-iron gratings flush with the surface will deliver it to underground drains.

Jacksonville represents a compromise between the Corpus Christi and Saufley fields. There the runoff from the runways is to be carried over the surface in shallow ditches which in turn lead to drains laid in the deep drainage ditches that were dug to facilitate the grading work.

The Army favors more elaborate provisions for drainage. Tampa, which is the largest field in the area where rainfall is very heavy, has concrete runways 150 ft. wide beyond which are surface-treated shoulders 50 ft. wide. These shoulders slope gently away from the runway for 6 ft. where, at 150 ft. intervals, are placed drop inlets of reinforced concrete with reinforced concrete covers. Underground drains of concrete pipe laid parallel to the runways pick up the discharge from these inlets and carry it to main cross drains. Chanute Field is being equipped with cast-in-place concrete drain boxes with slotted covers along each edge of the runways. These drains connect with the large storm sewers traversing the landing field.

Drainage for Lowry Field

Lowry Field at Denver has the most elaborate system of field drains of any field visited. The runways are graded, flush with top of slab, for 40 ft. on each side of the paving. In cut sections the shoulder slopes on a 2 per cent grade up from the paving; on fills it slopes on the same grade down from the slab. For the most part the runway paving is crowned 6 in. at the center, draining to both sides, but in a few short stretches, because of local drainage conditions, the total

Traveling mixing plant preparing bituminous surfacing for runways of Saufley Field, one of the training fields at Pensacola.

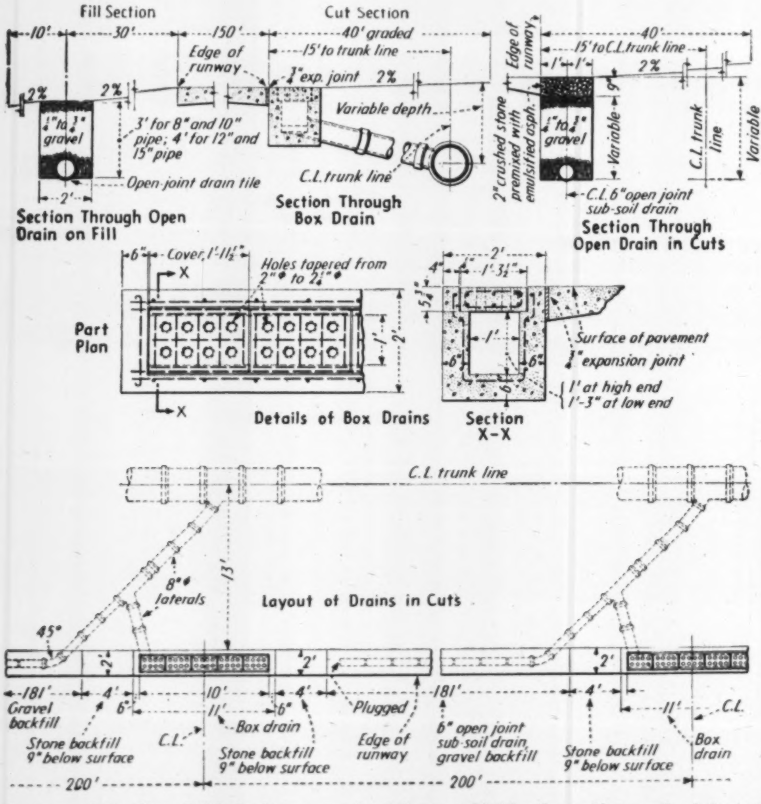
pavement slope of 12 in. is all to one side. Longitudinal grades on the runways vary from 0.03 per cent to 0.8369 per cent.

Drainage is simple in areas where the runways are on fills and the shoulders slope from the runway. An open joint drain of 8, 10, 12 or 15-in. pipe is laid in a trench 2 ft. wide and 3 ft. deep for the two smaller sizes of pipe, 4 ft. deep for the larger sizes. The trench, 30 ft. out from edge of the paving, is backfilled to the top with ¼ to ¾ in. gravel. The drains lead to the field storm sewer drainage system.

Where the runways are in cut the drainage facilities are much more extensive. At 200-ft. intervals a concrete box drain, 10 ft. long and 1 ft. wide, inside dimensions, is placed alongside and flush with the pavement. The box, cast in place with 6-in. concrete walls and bottom, is covered with precast reinforced concrete slabs, 5¾ in. thick, containing eight 2-in. inlet holes. An 8-in. lateral pipe connects each box drain with a trunk sewer. At both ends of each box is a trench 2 ft. wide and 9 in. deep, backfilled with 2-in. crushed stone premixed with emulsified asphalt in a quantity just sufficient to hold the stone in place without filling any of the voids.

In each 181-ft. stretch between the box drains is a 6-in. open-joint subsoil drain in a trench 2 ft. wide and of variable depths. These drain trenches are backfilled with ¼ to ¾-in. gravel to 9 in. from the top. The top backfill is 2-in. crushed stone permeated with emulsified asphalt. The drains connect with laterals leading to trunk lines.

Aprons and taxi ramps have supplemental drainage consisting of cast-iron inlets set flush with the pavement, which is sloped to the inlets.


Fill Section
Cut Section
10'
30'
150'
40' graded
Edge of runway
15' to trunk line
¾" exp. joint
2%
2%
2%
¼" to ¾" gravel
3' for 8" and 10" pipe; 4' for 12" and 15" pipe
Variable depth
Open-joint drain tile
C.L. trunk line
2'
Section Through Open Drain on Fill
Section Through Box Drain
2" crushed stone premixed with emulsified asph.
Edge of runway
40'
15' to C.L. trunk line
1'
1'
2%
9"
¼" to ¾" gravel
Variable
C.L. trunk line
Variable depth
C.L. 6" open joint sub-soil drain
Section Through Open Drain in Cuts
6"
Cover, 1'-11½"
Holes tapered from 2"⌀ to 2¼"⌀
X
Part Plan
1'
2'
X
Details of Box Drains
2'
4"
1'-3½"
5¾"
1'
6"
6"
6
Surface of pavement
¾" expansion joint
1' at high end
1'-3" at low end
Section X-X
C.L. trunk line
13'
8"⌀ laterals
Layout of Drains in Cuts
45°
2'
2'
2'
181'
4'
10'
4'
181'
4'
Gravel backfill
6"
11'
6"
Plugged
11'
C.L.
Box drain
C.L.
Stone backfill 9" below surface
Stone backfill 9" below surface
Edge of runway
6" open joint sub-soil drain, gravel backfill
Stone backfill 9" below surface
Box drain
200'
200'

System of landing field drainage used on Lowry Field where the most elaborate system that has been designed for any military field is being installed.

Airbase Runway Paving

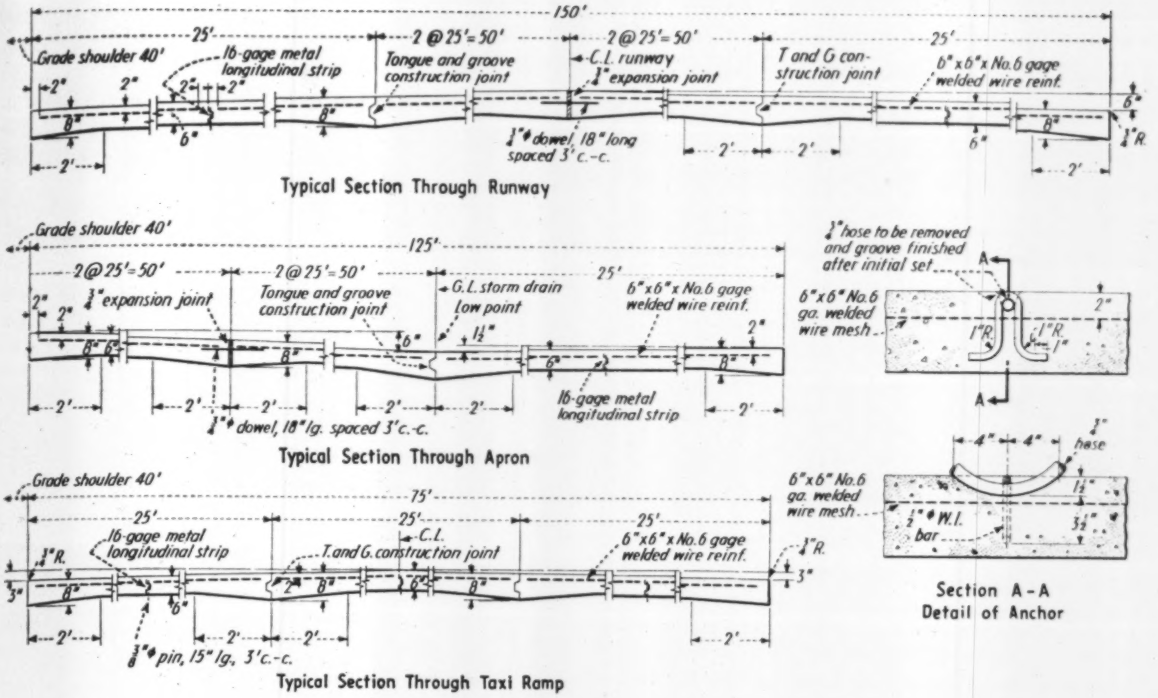
Nowhere in the construction of these bases is there more evidence of skillful use of local materials than in the paving of runways on the Navy fields, the Navy not having standardized on any type of paving. The Army, on the other hand, favors concrete paving, hence at only one of the fields visited was there any departure from the standard. That was at Chicopee Falls, Mass., where temporary runways are being laid at present. Army runways are 150 ft. wide, and some fields are to have graded shoulders that will be given surface treatment. Navy runway widths are 300 ft. generally, with grading carried out to a width of 500 ft. Both Army and Navy lay out the fields for possible runway widths of from 750 to 1,000 ft.

Runway lengths vary, but few are under one mile in ultimate length, some, as at Tampa, are to be 7,000 ft. long, and a few at Lowry Field that are for heavy bombers are to be two miles long. Grades, quite generally are better than the CAA requirements for Class 4 airports, that is, under 1½ per cent.

No subdrainage is employed at any of the fields except Lowry as the soils, quite generally, are of a sandy nature; and only at Jacksonville is any soil stabilization employed in the subgrade. There, the deep beds of muck that were present in some parts of the field were completely removed and replaced with sand fill; at other points where the natural soil lacked adequate stability it is being mixed with more stable soil during the grading operations.

Paving at Corpus Christi

The paving work on the Navy field at Corpus Christi is just getting underway. The surface soil there is a very fine silica sand with very little clay or decomposed vegetable material. Thus it had attractive qualities for a soil-cement stabilized base with an asphalt top. The possibilities of such a paving were studied but it was found that in order to compete with a paving made entirely of asphaltic materials the top surfacing on the cement-stabilized base could only be ½-in. thick. Because of the heat, high winds and drifting sands at the site it was believed that it would not be possible to bind such a thin top surface to the base and keep it from peeling, hence that type of paving was abandoned in favor of one made of asphaltic material.



Typical Section Through Runway

Typical Section Through Apron

Typical Section Through Taxi Ramp

Section A-A Detail of Anchor

150'
25'
2 @ 25' = 50'
2 @ 25' = 50'
25'
Grade shoulder 40'
16-gage metal longitudinal strip
Tongue and groove construction joint
C.L. runway
$\frac{3}{4}$" expansion joint
T and G construction joint
6"x6"x No. 6 gage welded wire reinf.
$\frac{3}{4}$" ϕ dowel, 18" long spaced 3' c.-c.
2'
125'
$\frac{3}{4}$" expansion joint
Tongue and groove construction joint
C.L. storm drain low point
16-gage metal longitudinal strip
$\frac{3}{4}$" ϕ dowel, 18" lg. spaced 3' c.-c.
$\frac{3}{4}$" hose to be removed and groove finished after initial set
6"x6" No. 6 ga. welded wire mesh
75'
T. and G. construction joint
$\frac{3}{8}$" ϕ pin, 15" lg., 3' c.-c.
$\frac{1}{2}$" ϕ W.I. bar
$\frac{3}{4}$" hose
A

Sections of concrete pavement as used on Lowry Field. Similar sections are used on other Army fields.

The paving now being laid is of two-course asphaltic type made up of a 3½-in. base and a 1½-in. topping. The base is an asphaltic concrete made of native sand, washed shell and emulsified asphalt. This is to be mixed in a central plant now being set up and will be spread over the subgrade with paving equipment. On top of this is to be a hot-mix asphalt using the local sand. The latter will be mixed and spread by traveling mixers. Shell for the asphaltic concrete is to be delivered to the site in barges where it will be washed and processed for the paving. This paving is expected to cost less than 50c. per sq.yd.

Sand-asphalt at Saufley Field

Mixed-in-place sand-asphalt pavements are used on the fields in the Pensacola area. Saufley Field, now nearing completion, is a good example. Nearly one million square yards is required because, in addition to the 300-ft. wide runways 6,200 ft. long, a great area at the crossing of the runways is being paved to make a zone 1,000 ft. wide and 3,200 ft. long for use of the training squadrons.

The natural sand of the field is used for the paving after it has been freed of roots. Specifications call for 4.25 gal. of cut-back asphalt per square yard of paving having a compacted thickness of 5 to 6 in. A production rate of 600 sq.yd. per hour is called for.

Two types of machines are used, one processing a strip 8 ft. wide and the other treating one 25 ft. wide. For both, the required amount of surface soil is bladed up into a windrow where it is picked up by the traveling plant, processed and discharged at the rear. Subsequently the processed material is spread with blade graders and is worked by them to drive off the naphtha and to get a uniform distribution. When the proper consistency has been obtained the material is rolled. Rolling such wide areas without the development of ridges has been found much more difficult than on normal road work.

Grades on the runways of Saufley Field average around 0.7 per cent, the minimum being 0.3 per cent and the maximum 2 per cent on a short stretch near the end of one runway. The maximum crown is one foot in a 300-ft. wide runway.

Limerock paving at Jacksonville

Still another type of paving is used at Jacksonville. There a limerock pavement, surface-treated with asphalt oil, is being laid. This choice was made for two reasons, first because the Florida highway department experience with this type of pavement has shown it to be both serviceable and economical, and second, because it has a high salvage value should resurfacing be necessary on those parts of the field which may settle as a result of the speed with which the grading had to be done.

Fine grading of the runway subgrade is being very carefully done as the best insurance of uniformity in the thickness of the paving. Over this finished subgrade the limerock is spread by dump trucks and bulldozers, 6-in. wide boards set on edge being used as guides. Bladegraders follow the bulldozers and they in turn are followed by road rollers.

Rock is delivered to the field in 60-ton railroad cars on a spur track built for that purpose, and clamshell cranes load the trucks direct from the cars. Seventy-five cars, or 4,500 tons of limerock, are being handled in one shift, which is at the rate of 500 lin. ft. of 300-ft. wide pavement per day. This rate is sufficient to keep up with the three-shift grading operations previously described.

The surface treatment on this 6-in. compacted limerock base consists of 0.15 gal. of tar prime and 0.3 gal. of hot asphalt per square yard. On this is spread 45 lb. per sq.yd. of graded slag under 1 in. in size, then

0.25 gal. of hot asphalt is applied and over the surface 200 lb. per sq.yd. of fine slag is spread to be followed by 0.15 gal. of cutback asphalt. As a final operation the surface is sanded and broomed.

Because of the large yardage involved, about 900,000 sq.yd., it is expected that this pavement can be put down for 75c. per sq.yd.

Both soil-cement and asphalt are being used on the Army field at Chicopee Falls. Two temporary runways are being laid there at present. One is 150 ft. wide and 2,500 ft. long laid with a surface-treated soil-cement base, and the other is the same width but 5,000 ft. long, a 2-in. base of plant-mixed asphaltic emulsion and crushed gravel with a 1-in. top of asphaltic emulsion and fine aggregates placed in 15-ft. wide strips with a traveling paver.

Concrete runways

Typical of the Army airfield paving is the work on runways at MacDill Field, Tampa, and Lowry Field, Denver. The paving is of reinforced concrete 150 ft. wide. Details of Lowry Field pavement are given in the accompanying drawing; that at Tampa is very similar. There is a longitudinal expansion joint along the centerline of each runway; longitudinal construction joints further divide the pavement into 25-ft. strips, and deep metal plates again divide these into 12½-ft. strips. Transverse expansion joints are spaced 90 ft. apart, and the dummy joints divide these panels into 30-ft. lengths. The slabs are reinforced with 6x6-in. No. 6 welded wire mesh placed 2 in. below the top.

Hangar aprons and taxiways are of similar design. At Lowry Field a new type of hold-down anchor for planes on the aprons is being tried out. It consists of a ½-in. wrought-iron hairpin, buried in the slab, with the top flush with the surface, at 20-ft. spacing in both directions. A ¾-in. hose is slipped through the hairpin to form a rope groove in the concrete until the slab has set, then the hose is removed. Old-style anchors, on the completed adjacent apron, are hairpins with the top loop extending 1½ in. above the pavement, through which a tie ring is fastened.

Paving of the runways and apron is being carried out in the same manner and by the same equipment as used on multiple-lane superhighway construction. A home-made tractor-drawn subgrader, riding on the forms of the 25-ft. strips, cuts the subgrade to the desired profile, after which the grade is finished by rolling with a light roller. Aggregates are supplied from a central batching plant on the job, and are mixed in a dual-drum paver. Finishing is by mechanical screeds and finishing machines, a longitudinal finisher, and hand belting and brooming.

At Tampa, 4,000 ft. of concrete paving 150 ft. wide is being laid on three runways, which means a total of about 400,000 sq.yd. when allowance is made for intersections. A contract for the work was let late in July and must be completed in 140 days, hence the contractor has his plant laid out to produce 2,000 ft. of 25-ft. wide pavement in a 12-hr. day. This can be stepped up to 990 batches or about 2,300 ft. on good days.

This pavement also is laid in 25-ft. wide strips, the contractor moving from one runway to another whenever possible to give ample time for curing before adjoining strips are laid. Two 27E pavers working in tandem are used; the leading one has dual drums and places the 4 in. of concrete under the reinforcing mesh. As soon as the mesh has been spread a single-drum paver follows to place the top 2 in. of concrete. Behind the pavers come finishing machines and joint finishers, all moving forward on the steel side forms.

The fresh concrete is covered with moist burlap mats as soon as initial set has taken place; 24 hr. later these are replaced with kraft paper, which is left on for at least 120 hr.

Trenching machine cutting ditches for drains in a filled area on Lowry Field.

Buildings at the Airbases

All buildings erected under the 1939 appropriations are permanent structures, but all housing and some of the other buildings being put up as part of the expansion authorized this year are characterized as temporary; all, however, are more substantial than the temporary structures put up in the World War period, some of which are still in use.

Standardization has been applied quite extensively in both services to structures where economy can be obtained in that manner, but it has not been carried to the extent of precluding variations to adapt the structures to climatic conditions or to bring the structure into harmony with local architectural practices.

Hangars

No attempt is being made to provide hangars enough to shelter all the planes that will be in use at these bases; hangars are for temporary housing, as during repairs, while the normal complement of planes at any station will be in the open, hold-down anchors for securing them against movement by wind being provided in all aprons and parking areas.

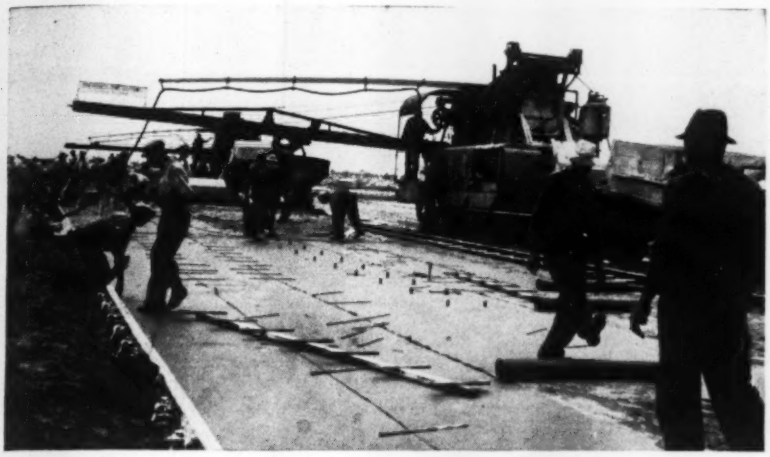
Structurally the hangars show the great progress that has been made since the World War. The 66-ft. and 110-ft. hangar widths of those days have been replaced by openings up to 250 ft. wide. The Army is building three types, the most common being a tied steel arch of 275-ft. span, 200 or 250 ft. long, and having unobstructed door openings 250x37 ft. Next in favor is an arch of 200 ft. span, and the third is also a steel arch of 255 ft. span being built under license from the Steel Arch Roof Construction Co. To accommodate the center fin of the tail of the planes, which in the largest machines reaches 45 ft. in height, a lift door 15 ft. square is arranged in the end wall of Army hangars over the center of the main door opening.

The Navy uses simple trusses of long span rather than arches to support the roofs of its hangars. The standard seaplane hangar has a net floor area 240x320 ft. in plan with two 160-ft. wide door openings, and the landplane hangars are 200x220 ft. with two 110-ft. door openings. Doors are multi-leaf sliding doors running on tracks set in the floor.

Leantos along the sides of the hangars for shops and offices are common practice in both services. Walls are of concrete, brick, corrugated asbestos or asbestos-protected metal and roofs are built-up bituminous composition on timber decks or of asbestos-protected metal. Some copper is used on shelters over door openings. Floors are of concrete.

Hangars of concrete shell arch construction are being built by the Navy at San Diego, Cal.

In Arctic climates the interior of the hangar is vestibuled by placing a sliding door similar to the main door at mid-length, so that the inner or working compartment of the hangar can be kept at tolerable temperatures.



Laying concrete paving on MacDill Field at Tampa. Two 27-E pavers work in tandem on this job, laying the pavement in strips 25 ft. wide.

Foundations for a seaplane hangar at a Navy base. High groundwater makes the use of wellpoints desirable in excavating for footings but also make possible the use of untreated piling. Beyond are frames of other hangars. They contrast sharply with the high arches used by the Army.

Demountable hangar frames comprising columns, cross truss sections adapted for field bolting, and connecting members and bracing have been provided for Army Air Corps service to permit of quick establishment of field facilities at emergency landing points. Some hangars of this type have been erected at regular fields, but generally they are intended for use at temporary locations only.

Concealed or protected hangars are not favored. The principle is that the place for the plane is on the field, ready for instant service, and that it should be in the air especially at time of attack or threatened attack. Accordingly the hangar enclosure is selected and detailed for weather protection only, not to resist bombs, projectiles or splinters.

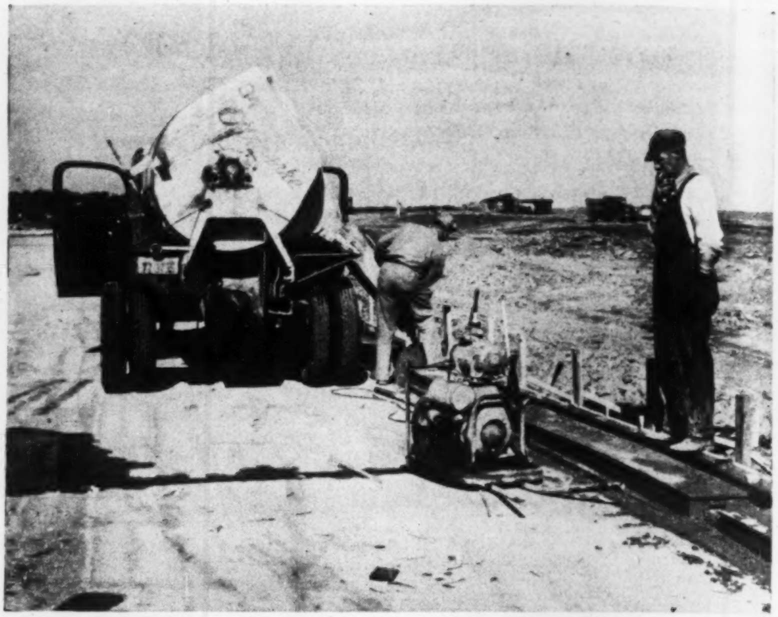
Shops and service buildings

Most spectacular of the buildings at naval air stations are the great assembly and repair shops. These buildings are being built initially with such plan dimensions as 640x580 ft., as at Jacksonville, and all are laid out so that this floor area can be doubled if needed. They are steel framed structures with fireproof siding and built-up roofs.

Special buildings

Buildings for special services are being put up at some of the training schools and at the Army repair depots. At Chanute Field in Illinois the Army has built its first building for engine testing and instruction of mechanics. It consists of a series of 26 test stalls separated by sound-proof observation booths equipped with double shatterproof glass. The stalls and booths are arranged along one side of a 60x580-ft. all-brick one-story building. Down the center of the building is a monorail hoistway, with leads into every test stall to handle the engine. Doors between the central corridor and each stall are heavy metal-clad type for sound insulation. The opposite or outside ends of the test stalls are fitted with full-size rolling steel doors, which are kept open during test runs of the engines.

Four steel posts, embedded in concrete mats insulated from the building foundations, carry each engine during the test. All interior partitions are solid brick masonry. Along the opposite side of the corridor from the test stalls are offices and class rooms. No vibration and very little noise are noticeable in these rooms, even with all test stalls in use.



Pouring concrete drain boxes for the runways of Chanute Field.

Another outstanding feature at Chanute Field is three combined school and hangar buildings. Each of these include a 200x275-ft. hangar, identical with the operations hangar except for length, surrounded on three sides by a one-story school building of brick wall and steel sawtooth roof construction. The hangars provide space for instruction in airplane repairing and servicing, and the schools contain classrooms and well-equipped shops for the training of mechanics, machinists and welders.

Quite different in character is the large ground school building at Pensacola which was started before the speed-up program was inaugurated but is large enough to serve the increased requirements of that program. It has a concrete frame, except in the auditorium, and brick walls with limestone trim to harmonize with other buildings in the station.

At the Mobile supply and repair depot the Army is putting up two very large buildings, an engineering shop, 770x640 in plan, and a depot supply building 480x861 ft. Each end of the big engineering shop is made up of two 190-ft. long sections of the standard 275-ft. arch roof hangar set side by side. Between these high end sections is a low section of simple steel framing in 25-ft. bays and having a monitor type roof. Side walls are of concrete below the windows and brick, corrugated cement-asbestos or asbestos-protected metal above. Roofs are of built up asphalt or asbestos-protected metal.

The depot supply building is made up of a group of steel-frame warehouses, 120x180 ft., separated by concrete firewalls, and a headhouse for offices. Down the center, with the warehouse units on each side are two railway spurs and a truck road depressed to permit direct loading to and from the warehouse floors. The roof of this structure is to be of mill type construction on which cotton seed oil gum is to be used instead of the usual bituminous pitch. All lumber used in these buildings is treated with preservative salts.

At McClellan Field near Sacramento the machine shop consists chiefly of two long bays equipped with overhead cranes and with a clear floor space of 150 ft. These bays can be subdivided by doors which fold up into the roof section when not in use. Roof construction, a distinctive feature of the shop area, consists of horizontal panels at alternately upper and lower levels connected by glass sections (corrugated wire-glass in panels about 2x8-ft.) inclined at about 60 deg. to the horizontal. This arrangement gives excellent illumination.

Special care was used in the design of the equipment repair building at

Laying concrete on the apron of a large seaplane hangar.

McClellan Field, a 70x202-ft. structure with two stories and basement in which the calibration and rating of delicate instruments is carried on. An unusually complete air-conditioning installation maintains the same air temperature the year around and controls humidity within close limits.

Housing at airbases

Housing at the airbases is covered in a separate article describing the types of permanent and temporary housing used by the Army and Navy.

Foundations

A variety of foundation conditions was encountered in building these bases. Except at three bases, most large structures have to be carried on pile foundations of some sort. No piling is required on any structures at Corpus Christi. At Jacksonville timber piles about 25 ft. long were used for the big concrete warehouse and for the aircraft storage building. Piles for the seaplane hangars ranged from 38 to 60 ft. These are of untreated timber as the groundwater is high. Under the big A. & R. shop, precast concrete piles about 40 ft. long were used because there was an uncertainty as to the ultimate level of groundwater under a building that covers so much ground area.

Driving conditions are good at Jacksonville. At Quonset and at Mobile, however, the firm underlying stratum to which piles are being driven has a very irregular profile. Poured-in-place concrete piles in fluted steel shells are used at Quonset and creosoted timber at Mobile. The big hangars at Tampa are carried on poured-in-place concrete piles in stepped steel forms but most of the other structures are carried on spread footings.

Only spread footings were required for building at Chanute and Lowry fields.

Seaplane ramps

Seaplane ramps at all the Navy bases are built to a standard design. They consist of a sloping reinforced concrete deck 50 ft. wide and 205 ft. long supported on 10-in. 42-lb. steel H-piles. The tops of these piles down to 4 ft. below waterlevel are incased in concrete covered with a heavy layer of asphalt pitch. Reinforced concrete beams on 15-ft. centers each way span between the pile supports and carry the 9-in. deck slab. The outer edges of the slab are cantilevered beyond the outer beam 2 ft. 6 in. and are surmounted by a low curb. The ramps have grades of 7½ and 10 per cent and are designed to carry 40-ton planes.

The land end of the ramps is made integral with the bulkhead wall along the front of the seaplane area. These walls are of steel sheet-piling capped with concrete and faced with concrete on the exposed side to allow water level.

Gasoline and oil storage

Gasoline and oil storage facilities are underground at most of the bases, using a water displacement system. From the storage tanks underground lines lead to distribution pits in the hangar areas.

Storage magazines

Storage magazines are of several types, usually vaults of reinforced concrete, waterproofed and buried in earth fills at widely scattered points in an area well isolated from other structures on the base. Steel doors and shutters and the steel reinforcing are grounded with heavy copper cables to protect the storage magazines against static electricity or lightning.

Utilities to Serve the Airbases

Water supply, gas, sewerage, electric current for power and light, communications and central heating facilities make up a considerable part of the cost of all of these bases. Water, gas and electric power are obtained from nearby cities wherever possible. At Jacksonville, Mobile, Pensacola and Rantoul, wells have been sunk for water. Pensacola and Jacksonville will have aerators at the headhouses, and zeolite softeners are being installed in addition at Jacksonville. All bases have large overhead storage tanks and most navy bases have ground storage reservoirs as well. Water mains are of cast iron except at Westover Field where cement-asbestos pipes are used. The cast iron mains at Mobile are cement lined.

Separate sanitary and storm sewer systems are quite generally employed, sanitary sewers being of vitrified tile and storm sewers of concrete pipe. Sewage is to be treated where treatment is necessary to conform with local practices or to protect the foreshore at the naval air stations.

Methods employed in digging

trenches for sewers, water lines and ducts were almost as varied as the fields visited. The worst ground conditions for trenching were found at Jacksonville and at Tampa—high groundwater and a fine sand that flows when sufficiently saturated. Because of these bad conditions the laying of sewer and water lines at Jacksonville was let by contract rather than being turned over to the WPA, which had no adequate plant. The contractor puts down wellpoints in advance of excavation on all lines and thus makes it possible to do all work in the dry.

At Tampa the WPA is doing the pipe laying under many difficulties, using sheeting extensively and diaphragm pumps to keep the water down. Sheeting also is required at Mobile but the soil is more stable than at Tampa. Corpus Christi has soil conditions that are the dream of all pipe layers, a uniform fine sand through which a trenching machine makes a clean cut whose sides stand without shoring while the pipe is laid.

At Westover Field large trenches are being dug with carrying scrapers and tractors, the soil being almost as sandy as at the seashore bases.

Duct lines for power and light lines are of fiber laid in concrete. Many miles of these ducts are required on the landing field for field lights and flood lights.

Roads

Many miles of highway are required both for access to these bases and for interior roads. Interior roads vary in character. Surface treated limerock, similar to that used on the runways, is to be used for the 13 miles of interior roads required at Jacksonville. No decision has been made as to roads at Tampa; main temporary roads have been surfaced with shell. Construction roads in the Corpus Christi base have been laid out as far as possible on the line of permanent roads and have had the surface stabilized with clay. These will be reworked and given a bituminous top for the finished road.

Organization for construction

The major part of the work described herein is being done under contract. A number of lump-sum contracts were let for the initial work at the Navy bases before the speed-up program was inaugurated, but subsequently, after Congress authorized the letting of cost-plus-a-fixed-fee contracts and called for speeding up the work, such contracts were let for all large construction operations remaining to be done. Most of the permanent building work at Jacksonville and Pensacola is being done under lump-sum contracts; all temporary structures are cost-plus-fixed-fee work. At Corpus Christi and Quonset, bases that were started after the speed-up program was inaugurated, all work is on a cost-plus-fixed-fee basis.

Miscellaneous grading not covered by the contract work at Jacksonville is being done by the WPA as is clearing, other than on the airfield, fencing and road building. The work is under local supervisors and is well organized. Similar operations

MAJOR CONTRACTS FOR CONSTRUCTION WORK AT THE AIRBASES

The following firms have taken large contracts for construction work on the airbases described in the accompanying article. The number of small contracts is so large that space does not permit listing them all.

Naval Air Station, Quonset, R. I.

George A. Fuller Co., and Merritt-Chapman & Scott Corp. *A fee contract of $24,204,000 for construction of the entire base.*

Naval Air Station, Jacksonville, Fla.

Duval Engineering Co.; George D. Auchter Co.; and Batson-Cook Co. *A fee contract for $13,856,000 of work not under contract at the first of July, 1940*
Earlier contracts include:
Standard Dredging Co. *Dredging*
Harvey & Quina. *Pier, bulkhead, ramps, clearing*
Aqua Systems, Inc. *Gasoline storage and distribution*
Hillyer & Lovan. *Storehouses*
The Steel Construction Co. *Steelwork for hangars*
S. S. Jacobs Co. *Senior officers quarters*
Blythe Bros. Co. *Power plant building, railroad line, sewers and water distribution*
Henry C. Dupree. *Power plant equipment*
Smith & Pew Const. Co. *Hangar foundations, magazines*
Virginia Engineering Co. *Completion of two hangars*
Jones & Laughlin Steel Corp. *Steelwork, A. & R. shop*
Doyle & Russell. *Superstructure, A. & A. shop, industrial buildings*
Artley Co. *Barracks*
Northeastern Const. Co. *Operations building*
Boyd & Goforth, Inc. *Water softener, sewage pumps*
H. B. Nelson Const. Co. *Electric distribution system*
Industrial Plumbing & Heating Co. *Steam distribution system*
M. C. Caddell. *Roads and walks*
T. A. Loving & Co. *Bachelor officers quarters*

Naval Air Stations, Pensacola

Hardaway Contracting Co. *A fee contract for $4,000,000 for extensions not covered by earlier contracts.*
C. C. Moore Construction Co. *Runways and drainage, Saufley Field*
Smith Engr. & Const. Co. *Runways, roads and drainage, Saufley Field*
Harvey & Quina. *Seaplane ramps, bulkhead and paving, sewers*
Standard Const. Co. *Seaplane hangar*
Virginia Engineering Co. *Hangars, barracks, industrial building, Saufley Field*
A. K. Adams Co. *Aircraft storehouse*
Batson-Cook Co. *Ground school, welfare building*
Southeastern Construction Co. *Laundry and bakery buildings*
V. P. Loftis. *Operations buildings, administration and recreation building, Saufley Field*
Aqua Systems, Inc. *Gasoline system, Saufley Field*
E. & E. J. Pfotzer. *Motor test buildings*
Kansas City Bridge Co. *Repairs to quay wall and pier*

Naval Air Station, Corpus Christi, Texas

Brown & Root, Inc.; W. S. Bellows Const. Co.; and Columbia Construction Co. *A fee contract for $23,381,000 for construction of the complete base.*

Westover Field, Chicopee Falls, Mass.

Tuller Construction Co. *Hangars*
Daniel O'Connell's Sons. *Runways*
T. A. Pearson Associates, Inc. *Heating plant*
Ley Construction Co. *Gasoline fueling system*
Bass Engineering & Const. Co. *Central heating plant*

MacDill Field, Tampa

Ebersbach Const. Co. *Runway and apron paving*
Aqua Systems, Inc. *Fueling system*
Chicago Bridge & Iron Co. *Elevated tank*
Cantral Contracting Co. *Hangars*
A. J. Honeycutt Co. *Fire and guard house, communication center, warehouse, officers' quarters*

Southeast Air Depot, Mobile

Beers Construction Co. *Warehouses and aircraft reclamation bldg.*
Foster-Creighton Co. *Depot supply building and engine repair shop*

Chanute Field, Rantoul, Ill.

Kuhne-Simmons Const. Asso. Inc. *Hospital group buildings*
Manhattan Const. Co. *Two hangars, annex to operating hangar*
J. C. Boespflug Co. *Temporary barracks*
W. M. Conway. *Paving for training camp*
Kramp Const. Co. *Aprons and drainage*
Lipman Const. Co. *A.C. Technical School No. 3 and barracks*
T. S. Willis. *Headquarters Bldg., hangars and school bldg.*
H. G. Gorlitz Co. *Paving runways and drainage*
Brockmeyer Const. Co. *Radio Transm. Bldg.*
F. A. Somers Co. Inc. *Grading*
Henry Bros Co. *Central heating plant*
J. L. Simons Co. *Technical Schools 1 and 2*
Chicago Bridge & Iron Co. *Elevated tank*
Wolff Construction Co. *Two theatres*

Lowry Field, Denver

Mead and Mount Construction Co. *Barracks, central heating plant*
Manhattan Construction Co. *Hangar No. 2 and annexes*
Peter Seerie. *Steam distribution system*
J. A. Bass Co. and W. C. Smith, Inc. *Temporary housing*
J. B. Bertrand, Inc. and Peter Kiewit & Sons Co. *Concrete runways*
F. J. Kirchof Const. Co. *Photographic and clerical schools and armament building*

are carried out by WPA at the Pensacola fields, but no WPA men are used at Corpus Christi.

The Army has let no cost-plus contracts for airbase work. Hangars and other large buildings usually are let on lump-sum contracts, as is paving work, but many small buildings and some housing is WPA work.

Without exception, at the fields visited, the officers in charge spoke well of the way in which WPA operations were organized and handled.

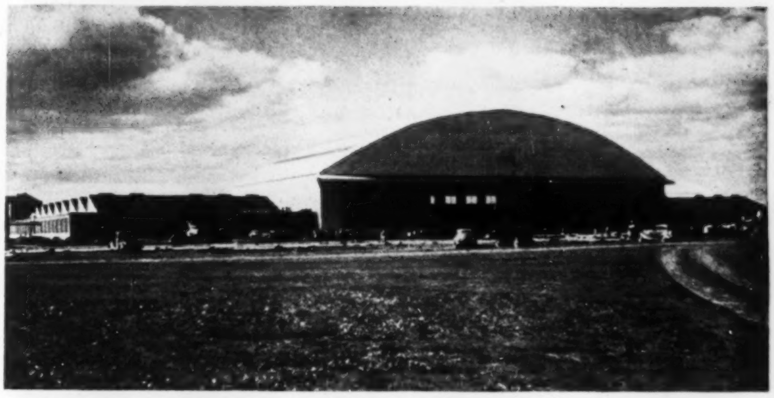
Design and engineering work

Basic designs for all structures for naval shore establishments were developed in the Bureau of Yards and Docks in Washington, but in the interest of speeding the construction program the preparation of detailed plans is being done by the firms of Albert Kahn, Detroit, and Robert & Co., Atlanta. The firm of Robert & Co. also is in charge of the major part of the field engineering work at Jacksonville and Corpus Christi. Engineering or architectural work on some structures at the bases visited was done by the following firms: Wyatt C. Hedrick, Inc., Houston; John F. Reynolds, Jacksonville; Jenks & Ballou, Providence; Marsh & Saxelbye, Jacksonville.

Designs for the Army buildings, except one type of hangar, are being developed by the Construction Division, office of the Quartermaster General, Washington, and the field work is being done by engineers and architects from the Quartermaster Corps.

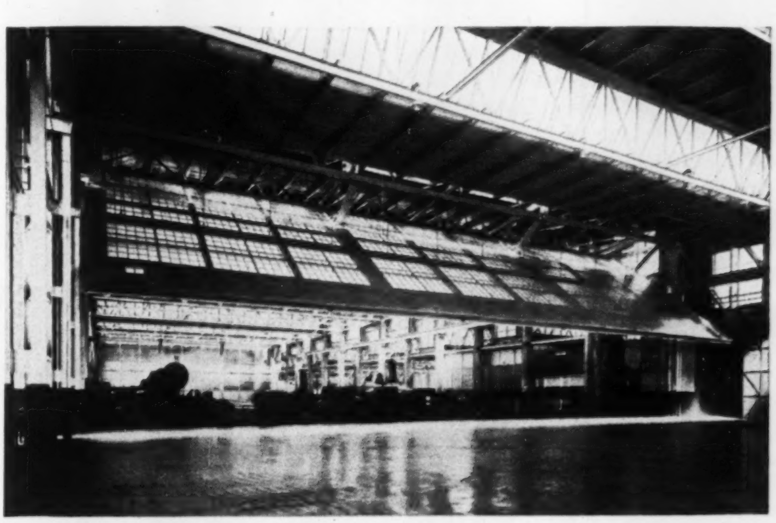
For the Navy, Rear Admiral Ben Moreell is Chief of the Bureau of Yards and Docks at Washington; officers in charge of construction at the Naval air stations visited are Comdr. R. V. Miller at Quonset, Comdr. C. H. Cotter at Jacksonville, Comdr. E. D. Graffin at Pensacola, and Comdr. L. H. Moeller at Corpus Christi.

For the Army, Brig. Gen. C. D. Hartman is Chief of the Construction Section, office of the Quartermaster General; Major M. A. McFadden is constructing quartermaster at Chicopee Falls, Mass., Major Robert B. Johnston at Tampa, Major A. F. Dershimer at Mobile, Major Geo. S. Deaderick at Montgomery, Major B. F. Vandervoort at Rantoul, Ill., Lieut. Col. C. H. Jabelonsky at Denver and Major Wm. J. Gainey at Sacramento.

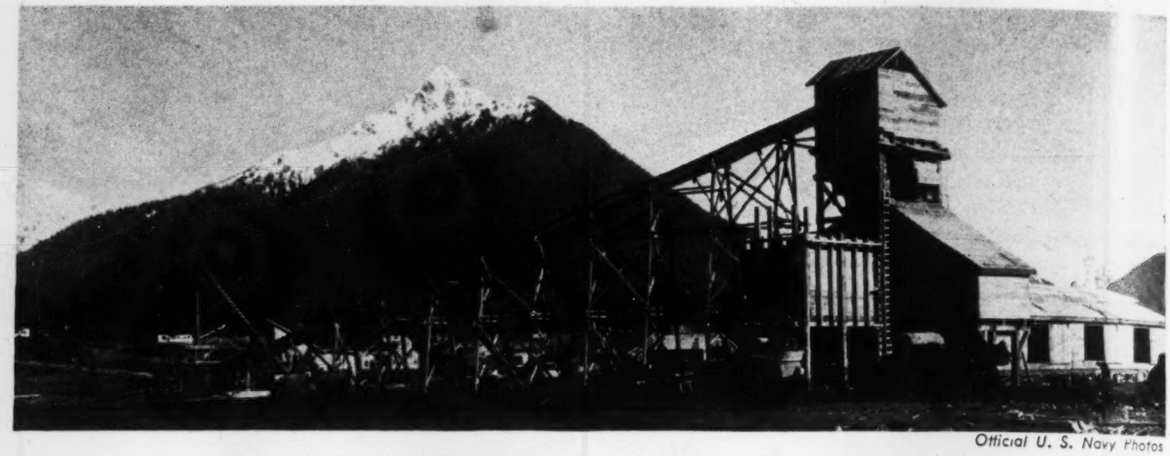


For its training field for mechanics the Army has surrounded standard hangars with wide low buildings that can be used for shops and classrooms. This one is at Chanute Field in Illinois, a field devoted to the training of mechanics.

Navy seaplane hangars are unusual for their great width of floor, 320 ft., which is unobstructed except for column bents at the center of the door openings and a column at the center of the floor. The exterior architectural treatment is varied at the different bases.



Flexibility in the shops of the Army repair depot at McClellan Field is provided by doors that fold up into the roof section. Glass in these doors keeps them from making major changes in the lighting, which is excellent throughout the shop.



Official U. S. Navy Photos

Concrete plant for Sitka airbase on a plain rimmed with snow-capped peaks.

Building Alaska Bases for Naval Aircraft

Contents in Brief*—Construction of two air stations for the Navy on the Gulf of Alaska presents difficulties because of weather and isolated location. A pumice deposit at Kodiak and heavy timber at Sitka complicated site preparation. Marine borers at Kodiak dictate use of steel piles. Use of fee contract given credit for keeping job ahead of schedule.

TWO AIRBASES now under construction in Alaska for the U. S. Navy, one at Woman's Bay near Kodiak on the west side of the Gulf of Alaska and the other on the east side at Sitka, involve widely different conditions, but each in its own way reflects the factors typical of construction in Alaska. The work is being done under cost-plus-a-fixed-fee contracts, $13,000,000 at Kodiak and $3,000,000 at Sitka. All elements of the jobs are either up to or well ahead of the schedule, which contemplates completion by September, 1942. Because of uncertainties arising from extreme isolation, weather, and physical characteristics, and because work had to be started before designs were finished, the Navy is certain that no other type of contractual relationship would have permitted a similar accomplishment nor so well met the urgent need "to construct the two stations with the utmost of certainty, speed and economy."

The Kodiak base

The more northerly base, at Woman's Bay, is in a latitude roughly 1,000 miles north of New York City. The mean annual rainfall is 61 in. and, while temperatures are not very low, (85 deg. F. to —12 deg. F.) working conditions are bad; winter months have but few hours of daylight, and men working outside must be heavily clothed against cold, wind, sleet and rain, conditions that measurably reduce their output. Except for hemlock lumber, practically all building materials have to be shipped from West Coast ports, with numerous rehandlings. Freight steamers require 5 to 10 days to make the trip to the job from Seattle.

A construction camp for 800 people was first built, equipped for several years of occupation and provided with water supply, sewers, heat, light, power and whatever would be necessary to make the community entirely independent.

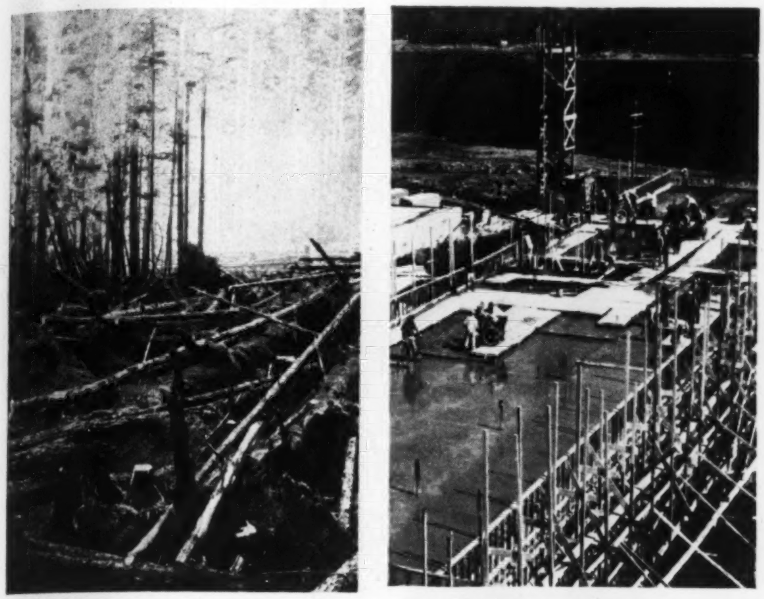
An item of importance at this base is the 18 in. of volcanic ash and pumice that overlies the entire area. A sequel to the 1912 volcanic eruption that blew off the top of Mt. Katmai, this fine dust, when stirred up by construction operations, greatly increases the wear on equipment and even on clothing and leather.

Permanent provisions at this base are for 600 people. The detached buildings for families are wood-frame structures with concrete foundations and cement-asbestos siding and shingles. Interiors are finished with plywood up to window height and beyond with plaster board. A central heating plant, burning oil, serves all buildings.

The larger buildings for permanent occupancy are of steel frame with corrugated asbestos on roof and sides over shiplap sheathing. The largest building is a 390x240-ft. seaplane hangar consisting of two bays. The larger buildings are designed for an earthquake-resistant factor of 1/20 g. and a 25-lb. wind load.

Aggregate for concrete, conveniently at hand in streambeds, is such that crushers are not required. Dredging is an important item because, in addition to the channel improvements which call for removal of some 900,000 cu.yd., the more important permanent buildings at the station are located on a hydraulic fill. This fill is being made behind a dike in such a manner that building construction can start at the shore end before all of the area has been brought up to grade.

Steel piles are being used for wharf and warehouse because of extremely severe marine borer conditions. *Plankton* is present in these waters in large quantities, all driftwood is riddled with borer holes and even creosoted piles are said to be attacked after 10 or 12 years. (This

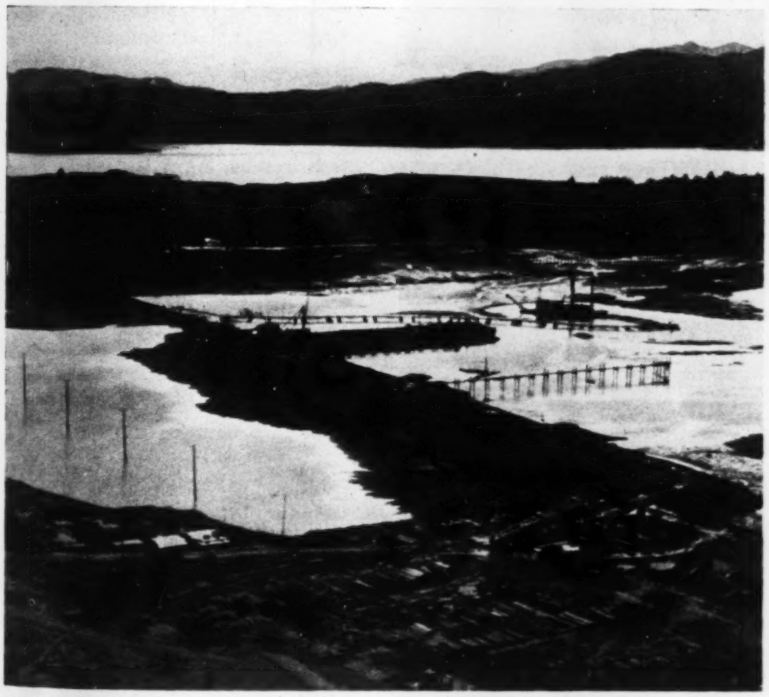


Muskeg as well as dense timber made clearing and grubbing expensive at Sitka. (Right) Barracks and mess hall under construction at Sitka. Concrete structures are used here in contrast to the timber buildings at the more isolated Kodiak base.

is in striking contrast to conditions at Sitka where untreated piles are said to have unusually long life.)

Work under way or nearing completion at Woman's Bay includes officers' and enlisted men's apartment houses, quarters and other buildings; water supply system, clearing, grading, rock excavation, a 600-ft. permanent pier, roadways, oil and gasoline storage tanks, etc. Rock drilling and dredging for the channel in the outer harbor is well ahead of schedule.

The water supply comes from Buskin Lake about 70 ft. above sea level which gives enough head for gravity flow (wood-stave pipe) to a pump at the camp which delivers to an elevated tank. Cement-lined steel water pipe is used, wrapped according to Navy specifications with an asphaltic coating. Temperatures are such that ample frost protection is afforded by trenches 4 ft. deep. Sewage is carried in vitrified clay pipe until diameters of 36 in. or more are needed, when concrete pipe is substituted. Because the system carries storm water as well as sanitary sewage, a 42-in. pipe was required for the ocean outfall.



Hydraulic dredge makes much of the site for the Kodiak base by dredging the necessary ship channels. Retaining dike and seaplane ramp are shown in center.

The flying field for land planes is located on a nearby low plateau where clearing and grading requirements were moderate and a gravel subgrade simplified drainage. A first consideration was the removal of the ash and pumice overburden.

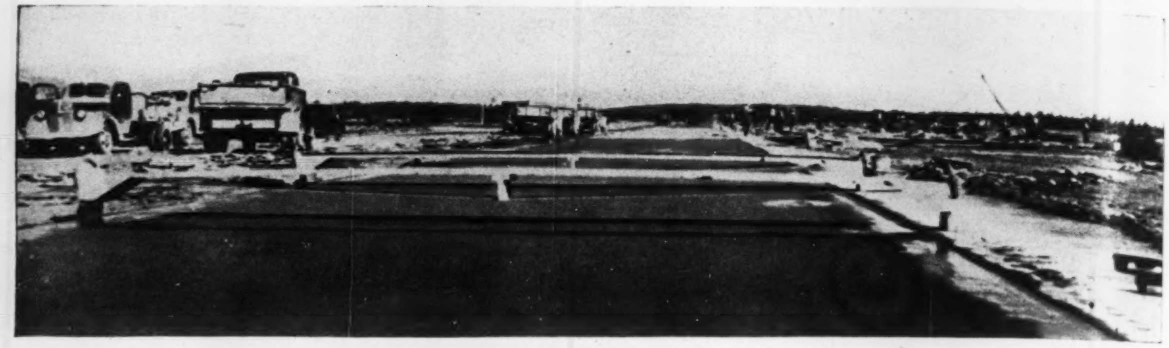
The base at Sitka

The Sitka base, located on a 200-acre island, has alongside it a deep water channel. Although the close proximity of the town of Sitka made it unnecessary to "start from scratch" at this base, as at Kodiak, there were other problems, particularly clearing the extremely heavy timber and dense undergrowth and grubbing and burning the wet stumps. This work was so difficult that on some parts of the area the cost was as much as $5,000 per acre.

Under these conditions, costs for a temporary camp would have been excessive and a better plan was the reconditioning and mooring alongside the work of an old passenger steamer. Here some 200 men were housed and fed while engaged in the work.

Essentially the requirements at this site are for a seaplane base including ramp, hangar, incidental buildings, storage tanks, barracks for 200 men, power plant, etc. The principal buildings have concrete frames. The sheltered conditions and the relatively milder weather greatly simplified many phases of the work at this base.

The contract for the two bases is held by a combination including the Siems-Spokane Co., Johnson Drake and Piper, Inc., and the Puget Sound Bridge and Dredging Co. The contract is with the Bureau of Yards and Docks, Navy Department, of which Rear Admiral Ben Moreell (CEC), U. S. Navy, is the Chief, and who in this case is the contracting officer. Other officers of the Civil Engineer Corps of both the regular Navy and the Naval Reserve are assigned as assistants and representatives of the contracting officer at the sites of the work and at the administrative offices in Seattle, Wash.



Concrete runway 150 ft. wide and a mile long was built in 3 weeks.

Army Builds an Arctic Airbase

Contents in Brief—*Rush construction of the Army's Fairbanks airbase was begun late last year. Throughout the intense cold of winter the timber was cleared, and tractor-hauled scrapers traveled over the 1,000-acre site stripping off the muskeg cover and preparing for foundation work. Now a mile-long runway is complete, quarters and powerhouse have been built, and water supply and steam-heated sewer system are in operation. Ready for use now, the base will be completed early next summer.*

ORDERS ISSUED in August, 1939, to build an airbase in the heart of Alaska confronted the Constructing Quartermaster of the Army with a job of exceptional difficulty. The chosen site, near Fairbanks, is remote from supplies and labor and is in a region of severe climate and perpetual frost, where the ground is frozen to great depth. Winter temperatures sometimes go to 60 below zero. But speed of construction was vital, and work had to begin at once and continue through the winter. In the face of all difficulties the airbase, known as Ladd Field, is now so far complete that the first contingent of bombers was flown in from Seattle three weeks ago.

Preparing the site

Five miles from the city of Fairbanks a flat, level plain of about 1,000 acres lies in a bend of the Chena River, tributary of the Tanana. Here it was decided to build a great airbase for Army flyers. The soil—sand and silt over gravel—afforded good foundation conditions, and ample water could be obtained by sinking wells in the gravel.

The dense stand of timber covering the site was rooted in muskeg, an 18-in. layer of moss over the silt. The ground under the moss is frozen all year, as the insulating effect of the muskeg blanket prevents penetration of the warmth of the summer sun; even at the end of summer, frost is encountered within 18 in. of the surface, and well drilling last winter penetrated 80 ft. of frost before entering water-bearing gravel. Geologists say that the depth of frost is still increasing. However, where the muskeg blanket is removed the perpetual frost recedes, and in time its upper limit drops well below the surface layer of seasonal frost.

Before field and building construction could begin, the site had to be cleared and stripped of this muskeg. The first crew was flown in (this was the middle of August, 1939) and started work within 24 hours. There was no time to call for bids, and for that matter plans on which bids could have been based were not available; only general sketch plans were at hand, all detail designs remaining to be worked out. For these reasons construction began and continued as a force-account operation. The designing, however, was done under contract by The Austin Co., Cleveland, which had had experience in Arctic construction for the Russian government.

In addition to clearing, stripping and leveling the site, a railroad spur 7 miles long had to be built to connect with the main line of the Alaska R.R. into Fairbanks. The river froze over by the end of September, but clearing and stripping continued on 24-hr. schedule and went on throughout the winter, even at 40 below zero.

After hand clearing, the moss was stripped by 16-yd. tractor-hauled carrying scrapers. These scrapers removed the muskeg cover together with the embedded roots and stumps by following the plane of separation between moss and underlying silt, the moss rolling up in the scraper bowl like a jelly roll. Differences of elevation over the site were small, not over 3 to 4 ft.; when these had been graded down by the scrapers, taking advantage of all surface thawing to give the scraper blade a start, the site was ready for utility and building work.

Foundations in frozen ground

Structure designs were ready by spring, and on April 1 the first transport load of material started north to Alaska, bringing construction equipment, cement, reinforcing steel and lumber. Foundation excavation, well drilling and construction of a pipe subway connecting all the buildings, the "Utilador," were taken in hand by May 1. Most urgent were the power plant footings, the Utilador excavation, sewers and Imhoff treatment plant, for unless these were completed by winter an entire year would be lost.

Excavating the frozen ground

proved to be something of a problem. Pavement breakers were tried, as well as jackhammers, steam pipes and blasting. Powder proved to be best. Drilling and shooting was done in shallow lifts, but otherwise quite as in rockwork. The frozen gravel had about the strength of a fair grade of concrete. About a month was required to get the footing excavations down and prepare the pipe subway trench.

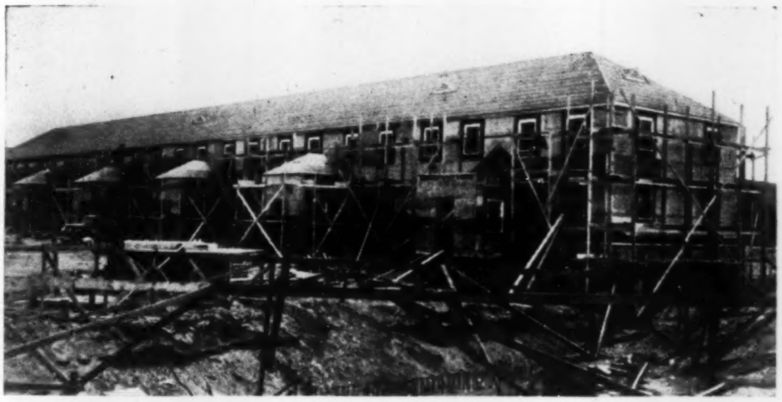
Foundation concreting, subway construction and sewer laying followed. Before any footings, floor or pavement were placed, an 18-in. layer of gravel was put down, with embedded pipe drains leading to a central sump—this to protect against frost heave. Concreting involved about 70,000 bbl. of cement and 200,000 yd. of sand and gravel. Aggregates were dredged from the river and passed through a washing plant of 140 yd. daily capacity. The mix was generally 1:2:4.

Special details of the buildings

Severe winter cold and abnormally large temperature range (from an extreme low of 69 below zero to 96 above) called for special consideration in designing the structures. Ample expansion allowances as well as thorough insulation were essential. Dwellings are fully insulated, sewer lines are steam-heated from buildings to treatment plant, and the plane hangar has vestibule construction.

Barracks and industrial buildings are built of steelframe, with asphalt-protected-metal sheathing, gypsum board lining, and mineral wool insulation. They rest on concrete basements and have reinforced concrete floors, a roof of 3-oz copper on paper on 2-in. plank, and double windows. Officers' quarters are row houses of wood frame and sheathing, with gypsum board lining, double roof covered with copper, and mineral wool insulation in walls and roof.

The hangar, 200x400 ft., is a truss-and-column structure with special temperature features: (1) at mid-depth of the hangar a sliding door duplicating the main door forms a vestibule to keep out cold when planes leave or enter the inner compartment; (2) the door tracks are steam-heated, and the doors are detailed with no through-steel and are filled with insulation to reduce heat losses; (3) expansion and contraction of the roof trusses are provided for by supporting one end on pendulum hangars from the top of the columns, the columns being braced by lean-to framing on either side of the building; (4) flexible insulated copper expansion seals at the eaves and two transverse copper joints in the roof provide for relative movement while avoiding temperature losses.



Housing at Ladd Field is of substantial construction—steel or wood frame, gypsum board lining, mineral wool insulation and copper roofing. All buildings have basements as an aid in combating the cold.

The outer hangar door and the vestibule door, each closing a 200x38-ft. opening, are sectional sliding doors of the type standard in army hangar construction. Each half of the door comprises five overlapping leaves running on parallel tracks of 35-lb. rail and held at the top between guides bracketed to the end truss. Side and gable walls of the hangar have asphalt-protected-metal sheathing, mineral wool insulation, and fiberboard or gypsum board lining according to location. The roof is copper on wood planking. In walls, as in the doors, through-steel is avoided, to eliminate cold spots and heat losses. The transverse expansion joints in the roof are of copper, double curved and backed with mineral wool, a special design worked out by Major Walters, head of the design division in the office of the Constructing Quartermaster General.

Runways and utilities

Two intersecting runways 150 ft. wide and 1-mile long are provided for, but the site permits of extending both to 2-mile length. The first runway was completed on Aug. 19, after 21 working days; the second is to be laid next spring.

Runway concrete was laid in 20-ft. strips, with a dummy joint every 20 ft. and a molded expansion joint every 60 ft.; the subgrade was prepared by placing an 18-in. layer of gravel, tile-drained. Slab concreting was done with steel forms, a paver traveling on the subgrade alongside, and a finishing machine, with oscillating screed and belt, moving on the forms. For surface drainage the runway has a slight crown and some longitudinal pitch.

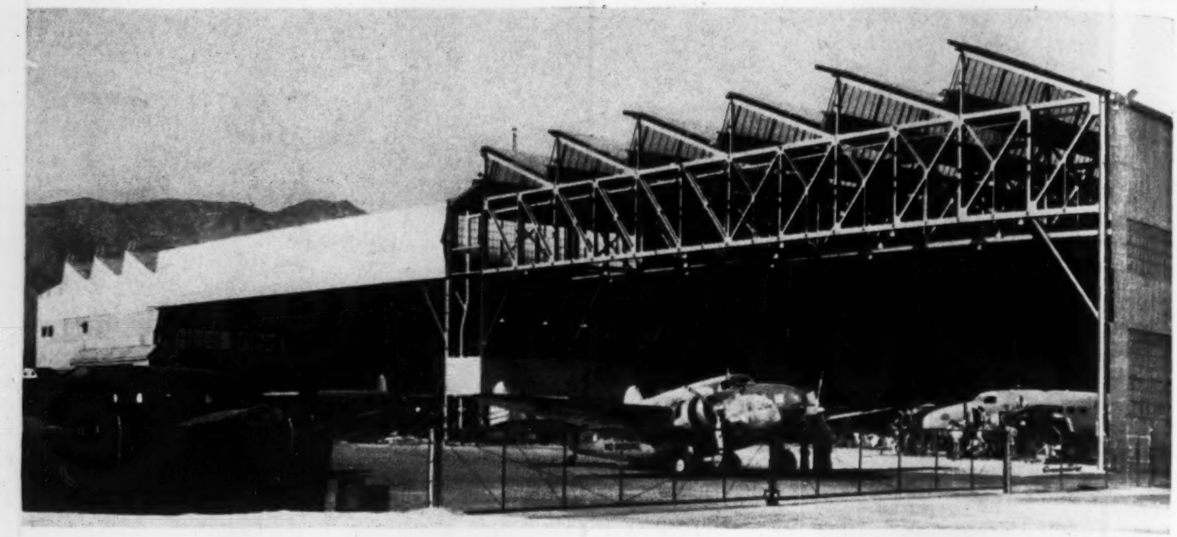
For the permanent water supply of the base, two wells (24 and 18 in.) with perforated casing, were driven to 100-ft. depth; they yield 3 mgd. A pump located in the power house distributes water to buildings and grounds through pipes carried through the pipe subway or Utilador, which also contains steam pipes, power and communication wires.

Sewers are heated by steam bled into them, to prevent freezing. They lead to an Imhoff tank treatment plant, whose effluent is chlorinated before discharge into the river.

Heating is of course a major problem in the Fairbanks latitude. It is necessary to provide heat every day of the year, and power is therefore obtained as a byproduct. Coal from the Healy River field is brought in 114 mi. by rail. The boiler installation is of 1,500 hp. The power plant, of 1,500-kw. capacity, supplies current for cooking as well as for lighting and power.

Temporary housing for 175 men—four dormitories and associated buildings—is now being put up, of sectional prefabricated construction designed by Major A. L. Violante, of the staff of the Constructing Quartermaster General at Washington.

Construction of the Fairbanks airbase is in charge of Major E. M. George, Constructing Quartermaster.



Lockheed prefers a type of roof heavy enough to support hoists.

Better Plants Build Airplanes Faster

Contents in Brief*— *Developments in the design of industrial plants for building aircraft, as typified by recent additions and new plant construction in southern California where more than half of this country's planes are built, include such features as 200-ft. column spacing, sawtooth roofs, and provision for earthquake forces in foundations and frame. Much manufacturing work is done outdoors on large paved areas. Doors often occupy one-third to one-half the wall perimeter of assembly buildings.

ON THE PRODUCTION LINES in southern California, from whence comes more than half the airplanes this country builds, are an interceptor-pursuit ship with a speed of more than 400 mph, one of the fastest craft ever produced, and a bomber with a gross weight of 70 tons and a 210-ft. wingspread, by far the largest plane ever built. These two airplanes symbolize in a way the growth of the aircraft industry and, when translated into army and navy requirements for hundreds of planes a month, explain the tremendous new plants which have sprung up with mushroom-like speed.

Modern aircraft plants in southern California show the result of applying structural design principles to the airplane company's requirements with particular reference to (a) local climatic conditions, (b) the building code, (c) earthquake considerations, and (d) insurance rates. Climatic conditions permit enclosures of no more insulating value than is provided by the low-cost steel frame with sheet metal sides and roofs. With this construction it happens that the requirements of earthquake resistance are contrary to the usual fire-resistant construction; the former favors some flexibility (typified by omission of X-bracing in walls) while the latter calls for rigid construction (as typified by masonry fire walls). The answer is found in subdividing into separate units with open spaces between for fire breaks. Airplane plants with upwards of 1,000,000 sq. ft. of industrial area in southern California are built without fire walls.

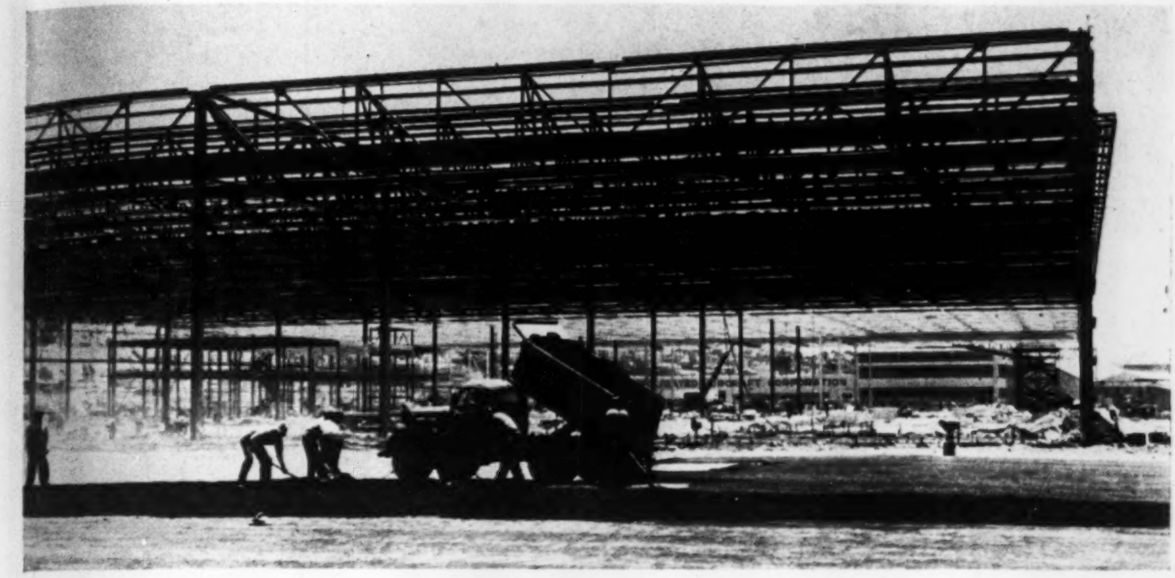
State laws call for a light earthquake provision, 0.02*g*, throughout California, but in Los Angeles County this is raised to 0.08*g*. Even outside the county limits, usual practice on the long industrial buildings of airplane plants is to use a seismic factor of at least 0.04*g* if wind load does not require its equivalent.

Since plant changes in the aircraft industry cannot be predicted with any certainty, structural designers prefer to include provisions in original plans for later expansion. Thus columns and footings are often made adequate for later addition of mezzanine floors wherever roof heights permit. In some plants mezzanine floors, paint shops and other subdivisions of space are built with bolted column bases and other details that will facilitate moving.

An important factor in rush steel construction on the west coast is the steel delivery from distant mills. West coast mills do not roll angles larger than 6 x 6 x ¾ in., no channels larger than 10 in., and no WF beams. Some airplane companies, learning from experience about constant expansion, place advance orders on a tonnage basis, specifying shapes and sizes later as needs form.

Typical rapid expansions

For several years the Lockheed Aircraft Corp. plant at Burbank has never been free of construction crews making additions. Furthermore, this company has recently formed a subsidiary, the Vega Airplane Co., which will materially increase production in an entirely separate plant nearby. Consolidated Aircraft Corp. at San Diego had 300 workers in 1935. On Sept. 1, 1940, it had 9,600 workers



Asphalt paving being placed in yard area at Consolidated where some 30 per cent of the manufacturing can be done outdoors. The yard area is equipped with all necessary utilities, placed in underground trenches.

and by Christmas, 1940, this force will be swelled to 15,000. Consolidated has put down asphalt paving over the entire yard area around its buildings to take full advantage of climatic conditions. Compressed air and electrical connections are conveniently distributed throughout this area, and as much as 30 per cent of the manufacturing operations can be carried on out of doors. Indoors and out, cab-control electric hoists operate on a strategically located monorail system.

Vultee Aircraft, Inc., at Downey, east of Long Beach, has built within the last year four major additions that have quadrupled the size of its plant. Despite this rapid expansion there is now discussion of a new unit that would, in one move, double the existing facilities.

Douglas Aircraft Corp., Inc., has made twelve major additions in six years to its Santa Monica plant and additions at the Long Beach and El Segundo branch plants will further increase the working area. A notable structure is the three-hinged arch hangar with its clear front door opening of 250x35 ft. (described in *ENR*, Oct. 15, 1936, p. 542). Recently, while the world's largest plane was under construction in this hangar, it was decided to lift a portion of the ship with tackles slung from the three-hinged arches. To avoid risking the plane, a 30,000-lb. test load was first hung from one panel point in each of two trusses. Under this load the deflection was only 25/100 in., and the lifting of the part was made safely.

Looking along the Douglas assembly line, in an area completely free of columns. Movable paint spray booth in right background

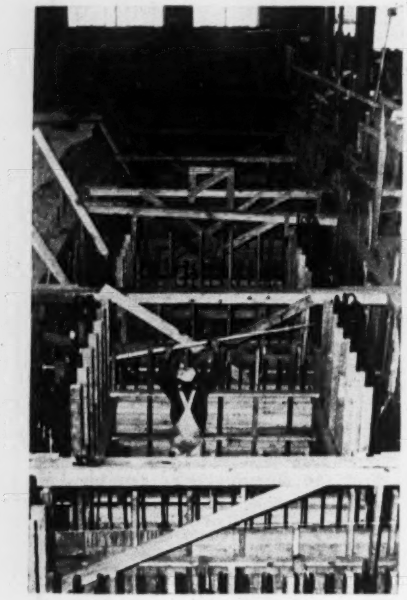
Plant layout

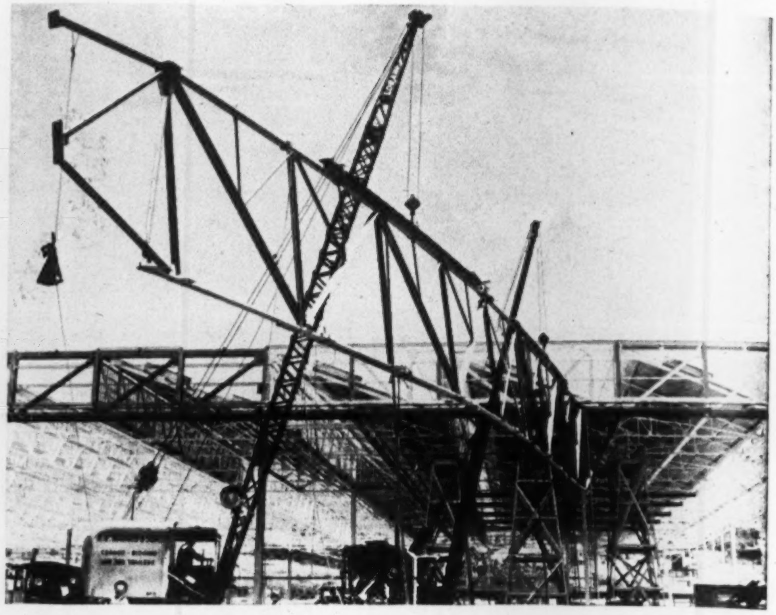
Despite the individuality of each plant, there are fundamentals which make for a basic similarity of layout in most modern aircraft factories. Receiving and warehouse facilities go together. Shipping of parts can go with receiving to good advantage. In this industry the finished product is usually "flyaway delivery" — only foreign orders are crated.

Near receiving will be located the metal cutting and shaping departments, including drop hammers and presses. Next come machine shop and subassemblies (wings, center sections, motor mountings, nacelles). Fuselages usually are set up in the final assembly area and to them are brought parts from subassemblies. Thus less headroom is needed and mezzanine floors are used in early stages; line production methods begin in final assembly areas where high headroom is provided. Present practice is to provide 35 or 40 ft. of headroom in final assembly areas. Wide column spacing and 200-ft. roof truss spans are usual practice. This holds even where the company is building only small ships.

Factory procedure in final assembly areas differ. Either one, two or three

Constructing forms for a 75-ton concrete inertia block under one of the eleven drop hammers at the Lockheed plant. The blocks are on springs.





Erecting 158-ft.-span truss to carry monorail hoists from building to building at Consolidated plant. Use of two parallel trusses with crossbracing between permitted the use of very light web and chord members in each truss.

production lines may be used, along which the ships are moved ahead the length of one ship at stated periods. At Douglas, ships in the production line advance along a track whose rail heads are at floor level. Some plants use dolleys; Consolidated, with its ubiquitous monorail hoists, does not use a production line.

Among the several special structures in plant layouts there is sure to be an office building. Ceilings here may not be over 8 ft. high and common requirements are for air conditioning, high intensity illumination and accessibility to outsiders not admitted to the plant.

Since the advent of fluorescent lighting there is a tendency to make a rapid change from other types to fluorescent units in industrial areas where close, accurate work is done. From intensities of 28 ft.-candles in final assembly areas, the range is up to 50 or 60 ft.-candles on the benches where exacting operations are performed. The Vega plant is to have fluorescent lighting exclusively, with intensities of 50 to 60 ft.-candles in all working areas.

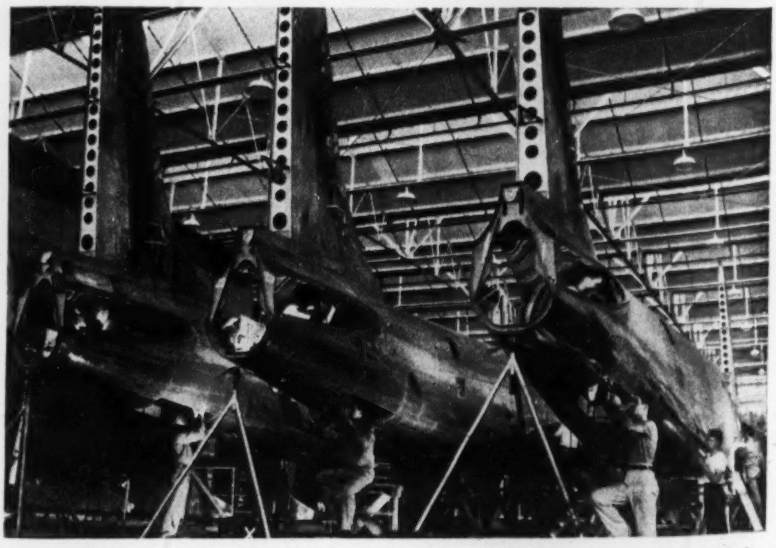
Foundations

On firm ground, individual footings under each column are considered adequately tied together by the 5-in. concrete pavement which usually has mesh reinforcement and thickened joints. Care is taken, however, to locate the pavement contraction joints so that more than one row of columns is included in each panel.

Recent extensions at Consolidated, made on filled mud flats, are carried on steel piles, 36 to 56 ft. long, two per column. Under earthquake shocks it is believed this fill will move as a mass, in which case flexibility in pile supports will be an advantage.

Foundation work also includes the construction of heavy inertia blocks on which drop hammers are cushioned to prevent transmission of vibration. Inertia blocks are mounted on springs, cork, rubber or patent resilients. The soft materials, sometimes "sandwiched" between a series of concrete blocks, cost much less than spring mountings but may be deteriorated by oil or water, may lose their resiliency and are difficult to replace. Spring mountings have the advantage that their reactions can be calculated, and they have long life.

Typical wall construction ranging up to 40 or 50 ft. high, consists of

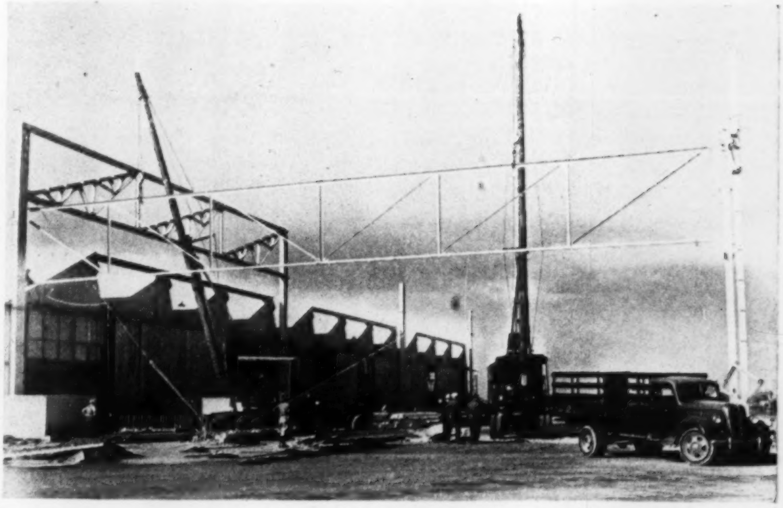


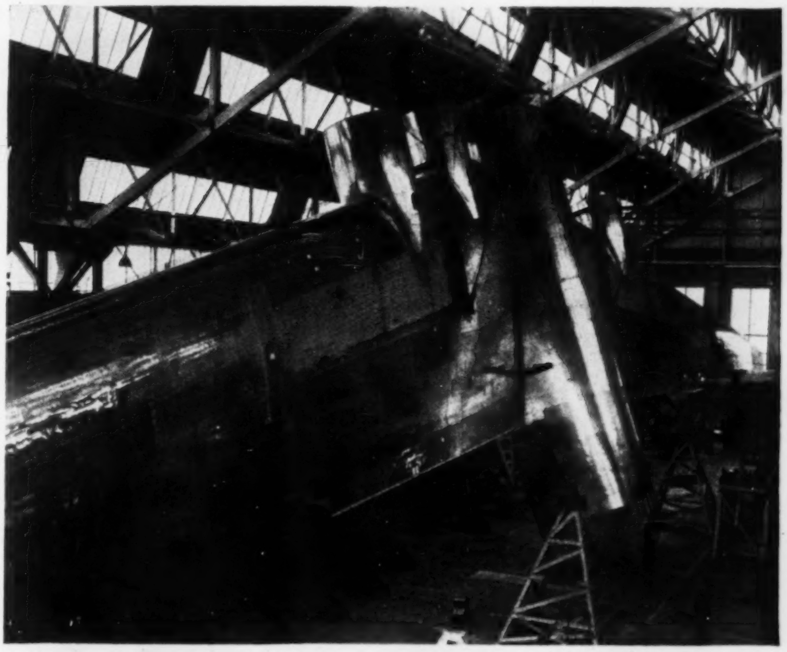
Good light from sawtooth roof at Douglas plant. Note the sway bracing and, in the transverse trusses, the extra triangular members.

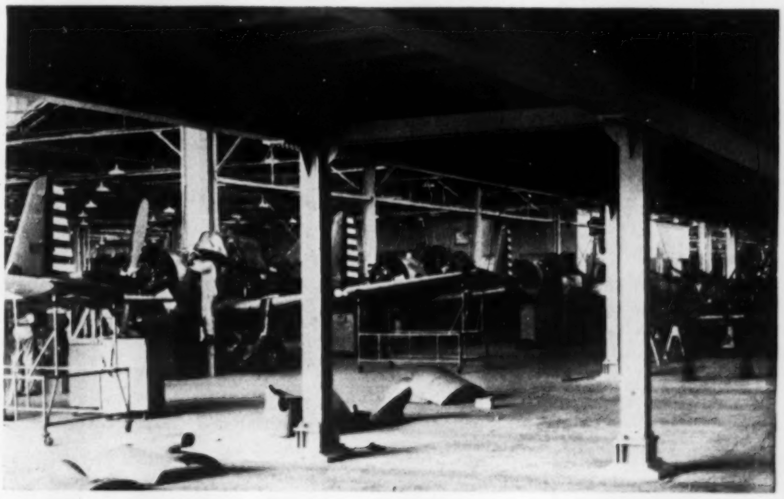
(Top) Beginning a new extension, with 60x100-ft. bays, at Vultee. Top chord of main sawtooth truss at left will be above the roof. It serves to brace the tall columns against earthquake forces.

(Center) This huge section of a Douglas plane, 210 ft. between wing tips, is being lifted by a two-point support from the three-hinged 250-ft. span roof trusses of the assembly bulldog.

(Bottom) Heavy mezzanine at Vultee planned for removal when necessary. Bolted bases stay the columns against possibility of seismic movement.







channel girts between columns, with strut or suspender rod supports. Girt spacing is worked out to carry a wind load of 15 lb. per sq. ft. Building sides facing on streets frequently have cement plaster finish with architectural treatment of some sort and are plastered on the interior. On other sides sheet metal wall finish is usual.

A notable exception to steel frame walls is the new Vega plant in which all seven buildings will have reinforced concrete side walls. This plant is under building code and insurance rates at Burbank such that fire walls are economical, as is an asbestos-covered composition roof.

Aircraft plants run to wide doorways—and lots of them. Clear openings of 200 ft. and more are common and, even if doors are not actually installed, wide spacing between wall columns is used as an aid to future expansion. The final assembly plant, dedicated at Consolidated last month, has 1,260 lin. ft. of doors in a building whose total perimeter is only 2,160 ft.

The most common door type is the multiple-panel steel frame carried on wheels, with T-rails at the bottom and guides at the top. Highway shipping limitations make it economical to use panels 12 to 14 ft. wide.

Plans now under consideration propose a door construction which consists of four vertical-lift sections telescoping into space in roof trusses above door openings 30 to 40 ft. high by 200 ft. long. The sections would be lifted at different speeds (lowest one fastest) so that all would simultaneously clear the doorway top.

Structural framing

Sawtooth roof construction with steel trusses and metal roofing is almost universal practice in southern California plants. The climate favors a low-cost sawtooth construction and the triangular truss bracing, now widely used, constitutes stays for the column top, highly desirable as earthquake resistance. Truss spacing is frequently in multiples of 25 or 30 ft. because 50 and 60 ft. are stock lengths of light, minimum-section members which split up evenly into 15-, 25- or 30-ft. bays.

Horizontal trusses, in the plane of the bottom chords, are used to aid the staying action of the sawtooth members in distributing horizontal loads more uniformly to columns. Roof framing of this sort, with steel purlins, can be kept down to a total calculated load, including a 20-lb. live load, of about 35 lb. per sq. ft. of area covered. This refers to total load on columns.

Some companies, notably Lockheed, favor roof construction with a strength margin for lifting special parts during assembly. Flying boat hulls are usually started bottom side up to simplify construction and then are lifted and turned over for completion of the upper part.

Maximum column spacing within economical cost is the rule, and this holds for column spacing in both directions even though there is no immediate need for the wide clearances transverse to the production line. The result is 150 or 200-ft. bays with lengths up to 600 or 800 ft. In these large areas 35 ft. is the prevailing clearance beneath trusses. This height makes seismic resistance at the column tops a considerable item; analysis shows that the large, clear floor spaces with high clearances cost nearly twice as much as the lower parts of the plant. On one job where both types are used, bays with a 20-ft. clear height and 60x100-ft. column spacing required less than 12 lb. of structural steel per sq.ft. of floor area. In adjoining 100x200-ft. bays with 35 ft. of headroom, steel totaled about 20 lb. per sq. ft. and much of the additional weight is chargeable to allowances for 0.1g seismic loads in the longer columns. Both these structures are entirely of steel and no sheet steel is included in the weight figures.

Mezzanine floors for storage, subassembly, bench work and making light parts are placed in that end of the plant farthest from final assembly. Headroom as low as 8 ft. may be used. Most often there are simple column supports with no diagonal bracing. There is advantage in having mezzanine supports arranged for easy removal.

Paint shops and booths

Location of paint shops is important in plant layout to avoid back tracking in production operations. Preference is for a main paint shop, supplemented by booths scattered about the plant in convenient locations, usually with only a hood and air exhaust. Fire risk is such that no considerable paint supplies are kept in the plant. Some companies send a paint truck around on hourly schedule to replenish supplies.

Because of the serious nature of fires, some plants have sprinklers installed over the entire plant area. Often they are of the type which turn on all heads when one head is opened by heat.

Large underground sprinkler storage tanks with independent source of power for maintaining pressure are used. At Vega the drainage from roofs will be such that rain water can be turned into the 600,000-gal. underground sprinkler system reservoir.

At Consolidated, the final finish building, has double walls to exclude dust, and air comes in through filters and heaters. The large size permits entire ships to be rolled in for camouflage finish.

A movable paint booth at Douglas is built up of six units, each an inverted "U", 12 ft. long and 47 ft. wide (inside), placed together, with telescoping motor-operated doors at each end. These units constitute a box-like enclosure, 16 ft. high and 47x72 ft. in plan, from which dust is excluded by spun-glass, oil-treated air filters in the ceiling. Each unit has motor-driven blowers with a capacity of 28,000 cu.ft. per minute, exhausting through a water curtain extending the full length of the unit on both sides. This carries the pigment down into a water bath where it is precipitated by chemical means. Venting to the roof takes care of vapors not caught in the water bath. This booth is astride the track on which the production line moves and thus each ship passes through as part of the assembly operation.

A number of Los Angeles engineers aided in the assembly of the foregoing data. Particular mention should be made of aid from Ellis Wing Taylor who has done the structural engineering for the Douglas plant since 1934, the structural work at the Consolidated plant since 1936, and has been consultant for Lockheed and other aircraft companies in this country and England. His firm is Edward Cray Taylor and Ellis Wing Taylor, architects and engineers.

Rapid Expansion of Engine Plant Leaves Time for Improvements

Contents in Brief—United Aircraft Corp.'s plant at East Hartford, Conn. has added 1,000,000 sq. ft. in the last 18 months. Latest addition incorporates improved waterproofing details in basement floors and 64-ft.-span roof trusses whose curved bottom chords give 4 ft. more headroom than old straight chord design.

DESPITE one of the most amazingly rapid plant expansions in American industrial history—from 400,000 sq. ft. in 1930 to 1,610,000 sq.ft. in 1940—improved structural details have been progressively included in the additions made to the Pratt & Whitney factory of the United Aircraft Corp. at East Hartford, Conn., where the famous Wasp and Hornet airplane engines are made. Two of these developments, relating to roof trusses and floor waterproofing, are particularly noteworthy.

Each addition to the plant has been designed and built under rush and emergency conditions, but the company believes that each has certain advantages over its predecessors. For example, since the plant is located on the flood plain of the Connecticut River, waterproofing of the basement floors has always presented a difficult problem. Principal trouble arose in making the membrane waterproofing (placed on top of a 3-in. ground layer of concrete, the "mud mat") fit tightly around the dowels that project from the footings into the columns. In the latest additions the problem has been solved by a detail that does not require the dowels to puncture the membrane.

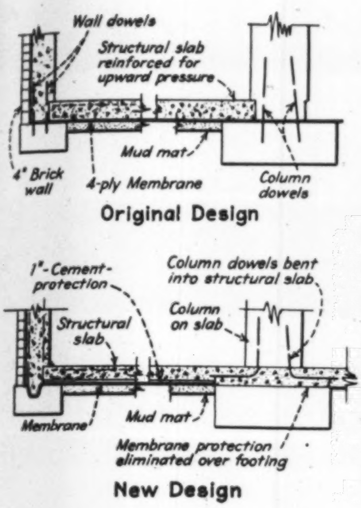

Wall dowels
Structural slab reinforced for upward pressure
Mud mat
4" Brick wall
4-ply Membrane
Column dowels
Original Design
1"-Cement-protection
Column dowels bent into structural slab
Column on slab
Structural slab
Membrane
Mud mat
Membrane protection eliminated over footing
New Design

Fig. 1. Improved basement floor waterproofing compared with old design.

Fig. 3. Ready for engine-making machines, latest addition to United Aircraft factory is characterized by curved chord trusses that give maximum headroom.

A comparison of the original and new designs is shown in Fig. 1. In the original design the membrane was placed over the mud mat and over the footings from which the dowels projected. Leaks developed around the dowels. Also since the structural slab was placed directly on the waterproofing, the reinforcing steel had to be handled carefully if holes were not to be punched in the membrane.

In the new design no dowels are used in the footings. As before the mud mat is poured flush with the top of the footings, and the membrane placed. A substantial key is placed in the wall footing, and the membrane is carried down into this before being turned up along the wall. Next a 1-in. layer of mortar is poured over the membrane to protect it from the slab reinforcing and from damage from construction operations; this mortar layer is stopped at the edge of the footing as it would be detrimental to good bearing at the column. Finally the structural slab is poured and, as the most significant detail of the design, the dowels at the interior columns, instead of passing down into the footing and through the membrane, are bent out into the slab; low unit stresses are used for these bent dowels in accordance with accepted practice. Such a design, it is believed, will make leaks from underground water impossible.

Another and more spectacular improvement relates to the roof trusses that carry the monitors. These trusses, which run transverse to the aisles, are supported on parallel-chord trusses on the longitudinal column lines. In the original building the monitor trusses had a 40-ft. span. This was increased to 64 ft. in the 1937 addition by the expedient of making the trusses continuous over the supports and using a suspended section in every second span.

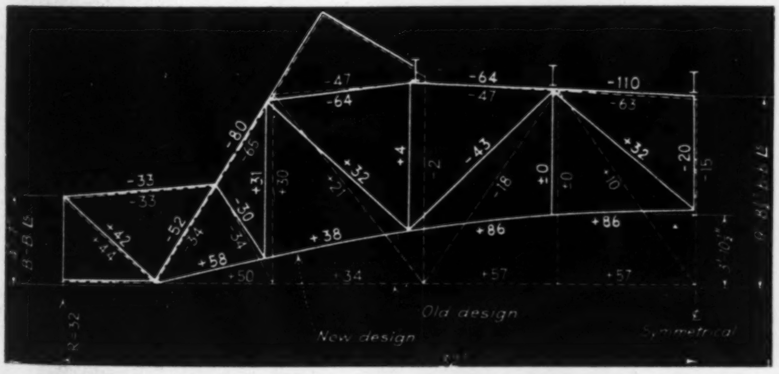

-47
-64
-64
-47
-110
-63
-80
-65
-33
-33
+42
+44
-52
-34
-30
-34
+31
+30
+32
+4
-2
-43
-18
±0
±0
+10
+32
-20
-15
+58
+38
+86
+86
+50
+34
+57
+57
R=32
Old design
New design
Symmetrical
3'-10½"

Fig. 2. How new curved chord roof trusses compare with former straight chord design in stresses and headroom.

In both the original and the 1937 truss the bottom chords were straight. When the 1939 program was initiated the engineers proposed a curved bottom chord design with advantages in increased headroom. This is the design used in all additions that have been made subsequently.

As shown in Fig. 2, it has a 64-ft. span as did its predecessors. Depth at the columns, 4 ft. 7 in., is also the same. But, except for a distance of 4 ft. out from each column, the new truss gives increased headroom over a horizontal chord type in an amount that reaches a maximum of 3 ft. 10½ in. at the center of the span. And since the elevation of the top chord is the same as formerly, shorter web members result.

As against a 9-ft. 8½-in. depth at the center of the old truss, the new truss is 5 ft. 10 in. deep. Some increase in size of chord angles is required in the curved truss: for the bottom chord, instead of 4x3½x$\frac{5}{16}$ in., as used in the straight chord design, the angles of the new truss are 5x3½x$\frac{3}{8}$ in., while for the top chord 5x3½x$\frac{3}{8}$-in. angles plus a 10x$\frac{5}{16}$-in. plate is required instead of 5x3½x$\frac{5}{16}$-in. angles. Whereas the straight chord truss weighed 4450 lb., including monitor steel, the comparable weight of the new design is 5000 lb.

All of the Pratt & Whitney design work has been done by Albert Kahn Associated Engineers and Architects, Detroit, and the latest additions have been built by the Turner Construction Co., New York, with the R. C. Mahon Co., Detroit, holding the subcontract for the steel.

Fifteen-Acre Plant for Bombers Built

Contents in Brief*—Allocation of structural steel orders, daily reports on fabrication and good teamwork sped construction of $1,800,000 addition to Boeing aircraft plant No. 2 at Seattle. Designed for construction of heavy bombers, layout includes underground tunnels giving access to various parts of the plant, maximum of unobstructed floorspace, overhead cranes serving entire floor area and sawtooth roofs.*

A 660,000-SQ. FT. ADDITION to Plant No. 2 of the Boeing Aircraft Co. at Seattle, completed last month, embodies the result of experience in factory needs that is unusually long for the airplane industry. The job is notable for speed of construction, despite a local strike of steelworkers. An elaborate system of wide underground access tunnels and rooms for lavatories and utilities keep floor areas clear so that overhead cranes have wholly unobstructed access. Columns and roof trusses also are designed to give a maximum of free area on the main floor. The cost of the new structure, including fences, railroad sidings and 80,000 sq. ft. of outdoor paving, but exclusive of power wiring and special foundations for heavy machinery, is $1,800,000. (The 660,000-sq. ft. area, which includes 44,000 sq. ft. in underground tunnels, also includes warehouse, boiler-house and paymaster's office.)

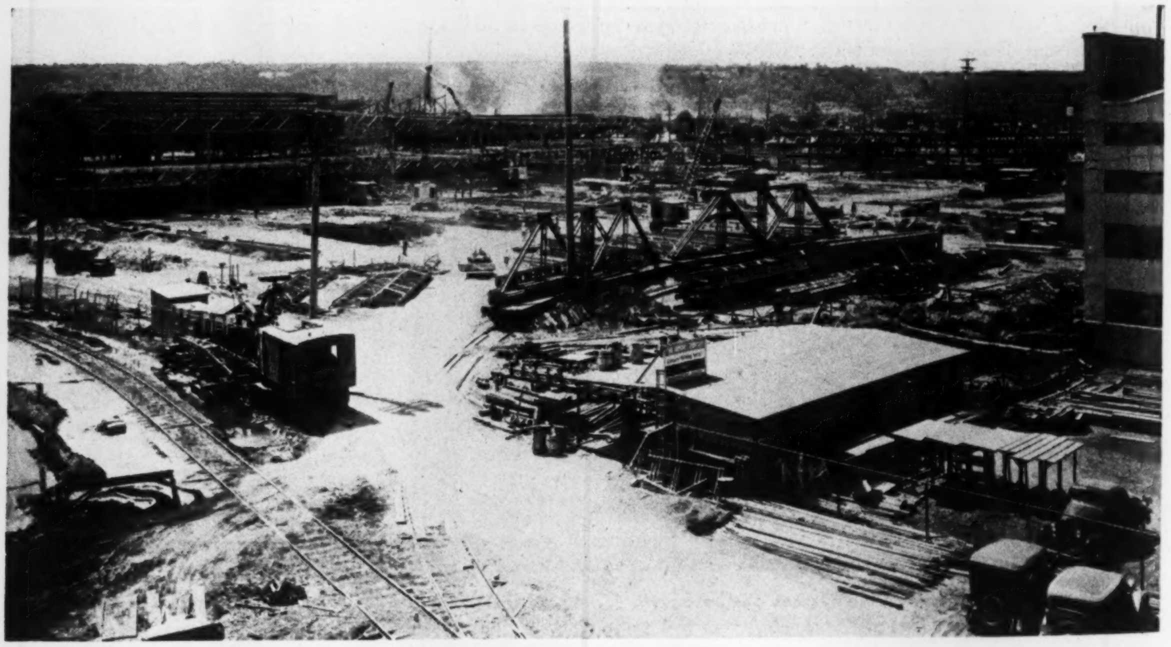
For more than twenty years this company made additions to its plant "when and as needed," acquiring facilities suited to building planes of many types. Four years ago this policy changed when construction began on a heavy bomber called "The Flying Fortress" which has a wingspread of 104 ft., weighs 22 tons, has 4,800 hp. in four engines and requires 40,000 manufactured parts other than duplicated items such as rivets. Instead of adding just another plant extension in which to build these bombers, the company selected a spacious new site for "Plant No. 2," laid out the area for development on a long-term, unit-construction plan and began with a 200x300-ft. unit. A year later a 250x300-ft. addition was constructed.

The heavy bomber was a success, and under impetus of the national defense move the company recently booked additional orders ($70,000,000) for 277 more of these planes, bringing its total orders as of Sept. 1, to 400, with an order for 235 more expected to be signed soon. These will be built in the addition just completed, which increases Plant 2 floor area by some 15 acres. On Sept. 1, 1940, Boeing's Plants 1, 2 and 3 were employing about 9,000 men. With the 75 per cent increase in total floor area made by the Plant 2 extension, the number of employees will rise to 15,000. As the latest step, announcement was made on Oct. 15 of the start on a new 20-acre addition to Plant No. 2, of the same design but larger than the one here described.

Underground structures

Foundations for the recent Plant 2 extension called for driving 3,250 piles, which penetrate a sandfill and rest on old swamp bottom. Four piledrivers were worked on double shift. There was some 95,500 cu. yd. of excavation, and then 17,000 cu. yd.

Fig. 1. No part of the site was free from construction as contractor pushed work on Boeing Aircraft addition.



in 90 Days

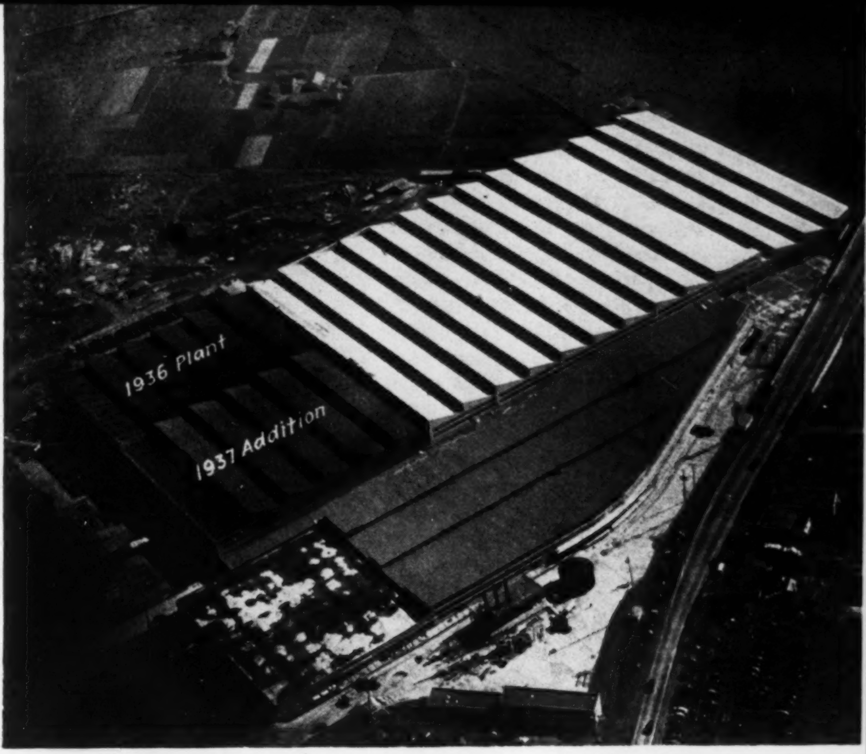
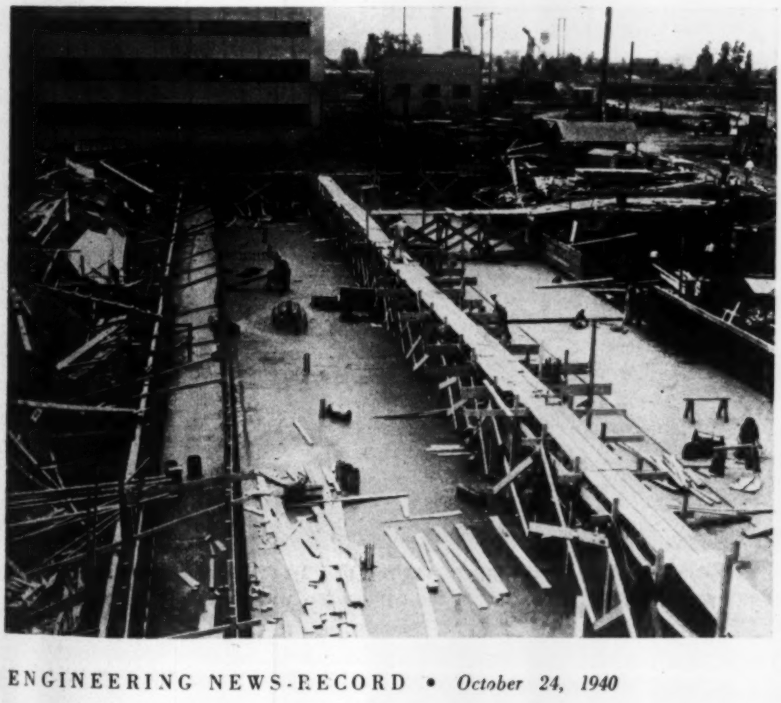


Fig. 3. As the Boeing plant appears today, with the 1940 addition practically complete. As we go to press announcement is made of start of work on still another addition that will double the size of the plant pictured.

of concrete was poured in sub-floor access tunnels and foundation walls. Main underground corridors are 16 ft. wide, have 10-ft. laterals and, with the sub-floor rooms, require 44,000 sq. ft. of paving below floor level. These tunnels carry all utilities and provide direct access to all floor areas. Except over concrete tunnels, the floor of the plant rests directly on the sand-fill and consists of 500,000 sq. ft. of 5-in. concrete paving. In the assembly area white cement is used in the paving to get a maximum of light reflection quality.

Because the rear of the plant extends to the Duwamish waterway, an arm of Seattle's harbor, a portion of the building here is carried on wharf construction. Piles and floorbeams are creosoted timbers; the wharf floor is reinforced concrete 6 in. thick. As the heavier plane parts are formed in this section of the building, numerous special foundations are required. Heaviest of these provides (with special pile clusters in a 20x30-ft. area) for a 300-ton hydraulic press of 2,500-ton capacity. Also, a 50x120-ft. bay has a 2½-ft. continuous concrete mat surmounted by eighteen pedestals 2 ft. high, each carrying a drop hammer. As a cushion between foundation and hammer, each pedestal is surmounted by a 4-in. layer of plywood and, immediately under the hammer base, by a 4-in. layer of cork. Numerous other special requirements, developed from experience in Plant 1, have been worked into the foundation plan for the new plant, for example, a shallow 20x30-ft. depression for an anodizing tank.

Fig. 2. Pouring the concrete floor in one of the underground areas which, with access subways, keep the plant floor clear of obstructions.



Plant layout

Locating the 152,000-sq. ft. warehouse area alongside the new plant makes it possible to deliver raw materials directly to the shop through a 29½-ft. covered distributing aisle between the two buildings. The flow of raw materials is into the rear of the plant at the waterway end whence progress is toward the assembly line at the front. Primary operations (drop-hammer forging, hydraulic press work, etc.) are done in the first 200x450-ft. section at the rear.

From this area materials pass into a 250x450-ft. section with two stories; below, with a 15-ft. headroom, are electric welding machine and sheet metal shops from where products move on two 5-ton elevators (full automatic, micro-leveling with push-button control) to the upper floor where primary assembly is carried on. The forward edge of this upper floor overhangs 5 ft., thus bringing this area under the overhead cranes of the next section.

The upper floor is carried on steel columns, but floor joists are 8x22-in. fir timbers (in which an extra 2-in. depth was allowed to give a strength margin for checking) overlaid by a

3x6-in. t.&g. sub-floor and finished with maple flooring. For this second floor level, three lavatories, two for men and one for women, are built in the roof trusses to leave the entire floor area unobstructed. On this floor, the only part of the plant where women work, the fabric used in portions of tail control surfaces is applied.

The third and last section, also 250x450 ft. in plan, has a 35-ft. overhead clearance to permit overhead cranes to bring sub-assemblies into this area from the upper floor of the preceding bay and to lift completed parts for transfer as sub-assemblies are completed. Final assembly is completed in this area which adjoins the assembly line in the part of Plant 2 built in 1936.

Superstructure

The superstructure is largely steel with sawtooth roof trusses carried on latticed columns having an unsupported height of 35 ft. The roof truss rise is 15 ft. and the maximum column length is 52 ft. For the most part the column spacing is 50 ft. longitudinally; transversely the 450-ft. width is divided into two 125-ft. bays and one 200-ft. bay. Transverse trusses across the 200-ft. bay are pin-connected to the columns at the lower chord (4½-in. pins), and the top connections which are riveted are not made until after the roof dead load is on.

The structure is designed for a 20-lb. wind load and the roof for a

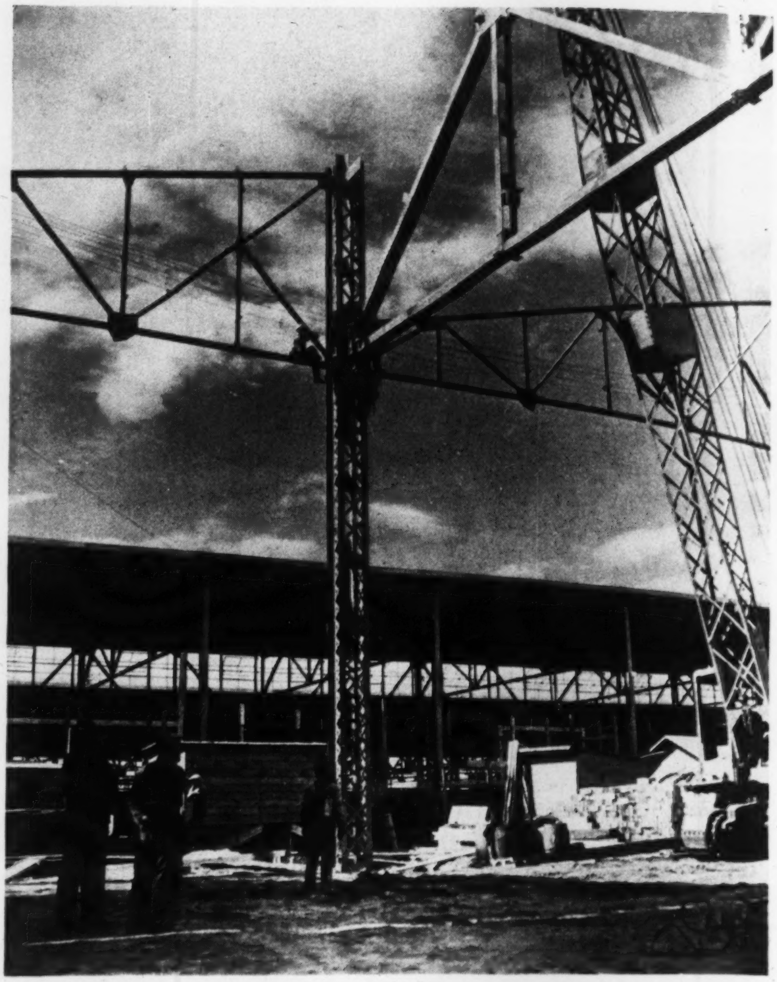


Fig. 4. Latticed steel columns are spaced 50 ft. apart longitudinally but 125 and 200 ft. transversely to give freedom for progress of parts in the direction of "line production." Here a 200-ft. truss is being pin-connected to a column.

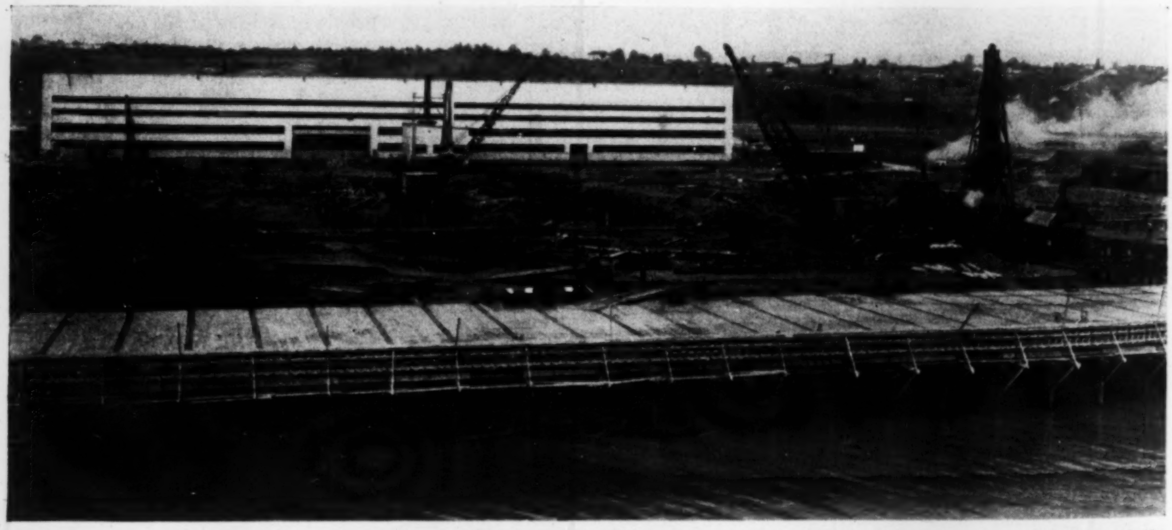


Fig. 5. As work began, piledrivers set to work on the 3,250 timber piles required and cranes began excavation of the 44,000 sq. ft. of access subways and underground rooms. The wharf in the foreground was necessary to support one end of the building.

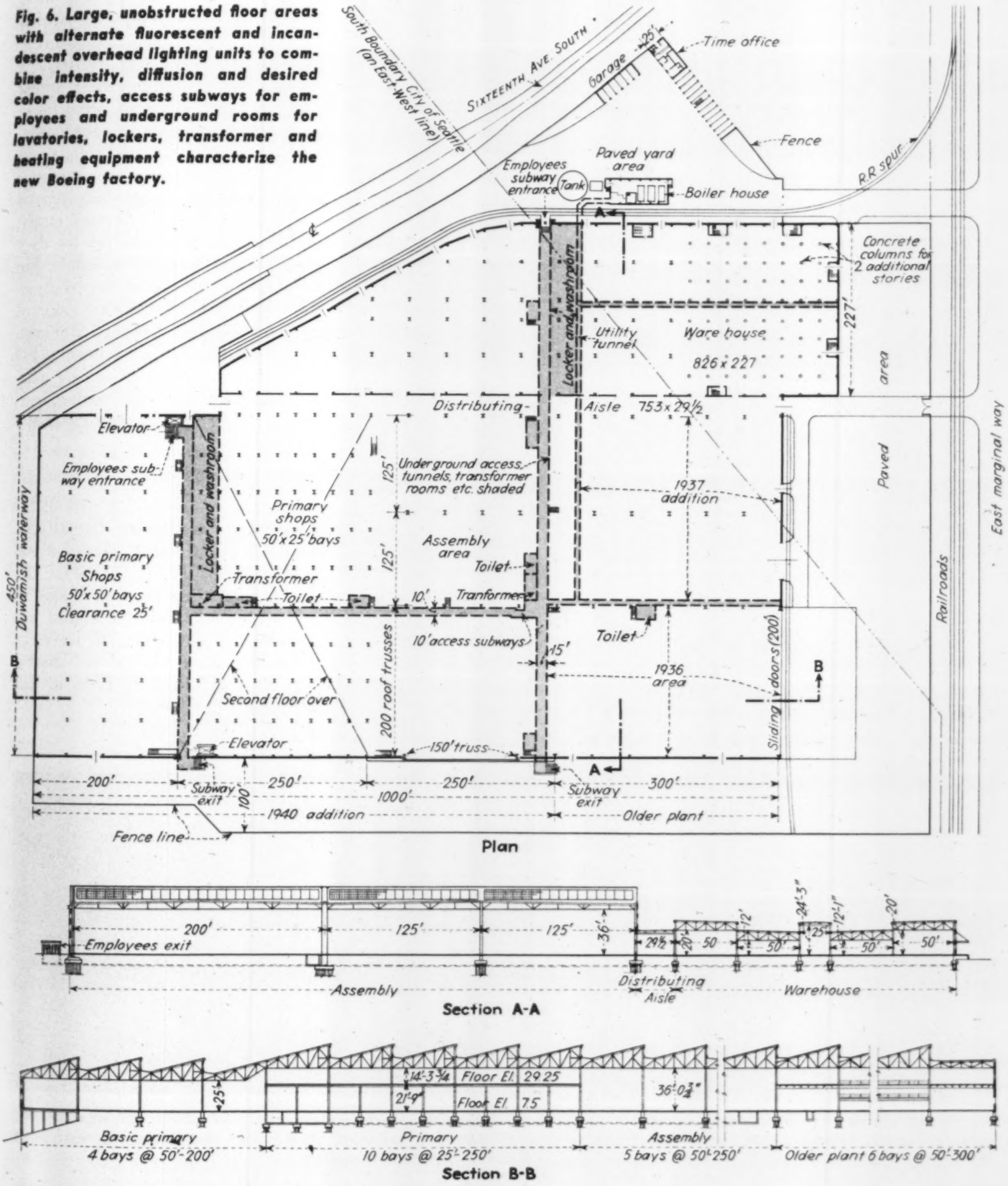
25-lb. snow load. Along the centerline of the structure a sheet metal fire-curtain is used in the roof trusses. Roofing consists of wood sheathing overlaid by ½-in. fibreboard and an aluminum surfaced composition roofing; sides of the building are covered with cement-asbestos board.

In the final assembly area a 150-ft. length of the south wall is clear of columns, thus requiring a 150-ft. longitudinal truss to carry ends of the 200-ft. transverse roof trusses. All roof trusses are figured for overhead cranes of 5-ton capacity, three to the bay. These are arranged for operation on three bridges, and two cranes may use the same bridge to give a total concentrated lift of 10 tons.

In the warehouse area construction resembles that of the plant itself except in a concrete portion in which upper floors, to be added later, will be used for engineering and drafting rooms. At least two of these rooms, 201x228 ft. in plan, are contemplated above the ground or warehouse floor level. Concrete construction was used here because of the need for air conditioning the engineering and drafting areas.

To maintain freedom from obstructions on the floor, all utilities are

Fig. 6. Large, unobstructed floor areas with alternate fluorescent and incandescent overhead lighting units to combine intensity, diffusion and desired color effects, access subways for employees and underground rooms for lavatories, lockers, transformer and heating equipment characterize the new Boeing factory.


South Boundary City of Seattle (on East-West line)
Sixteenth Ave. South
Garage
25'
Time office
Fence
R.R. spur
Paved yard area
Employees subway entrance
Tank
Boiler house
A
Concrete columns for 2 additional stories
Locker and washroom
Utility tunnel
Ware house 826 x 227
227'
area
Paved
East marginal way
Railroads
Distributing
Aisle 753 x 29½
Elevator
Employees subway entrance
Duwamish waterway
450'
Basic primary Shops 50'x50' bays Clearance 25'
Primary shops 50'x25' bays
Underground access tunnels, transformer rooms etc. shaded
125'
125'
Assembly area
Toilet
Transformer
Toilet
10'
Tranformer
1937 addition
Toilet
10' access subways
15'
1936 area
Sliding doors (200')
B
B
200 roof trusses
Second floor over
Elevator
150' truss
A
200'
Subway exit
100'
250'
250'
300'
Subway exit
1000'
1940 addition
Older plant
Fence line
Plan
200'
125'
125'
36'
Employees exit
29½
20'
50
12'
50'
24'-3"
25'
12'-1"
50'
20'
50'
Assembly
Distributing Aisle
Warehouse
Section A-A
25'
14'-3¾
Floor El. 29.25
21'-9"
Floor El. 7.5
36'-0¾"
Basic primary 4 bays @ 50'-200'
Primary 10 bays @ 25'-250'
Assembly 5 bays @ 50'-250'
Older plant 6 bays @ 50'-300'
Section B-B

underground; nevertheless there is no piping that is not accessible for its full length. Thus maintenance and flexibility are both served. This was accomplished by the use of utility trenches 18 in. wide and 2 ft. deep in which pipes are hung on brackets on one side. Manholes for access are provided every 20 ft., thus making it possible to put permanent concrete covering over the trenches after the utilities are in. The floor is laid out in 40x50-ft. rectangles with utility floorplugs (usually electricity and compressed air, sometimes also water) at the four corners. As often as possible these plugs are at columns.

Electrical current comes into the plant at 13,000 volts in underground cables and is stepped down in underground substations to 440 and 110 volts. The transformer rooms, alongside the access tunnels, range in size up to 24x80 ft.; lavatories and locker rooms up to 37x225 ft. Both, like the access tunnels, are under forced draft ventilation.

The entire plant is lighted by overhead units set in the roof trusses above the crane rails (or under the second floor system), and the units usually alternate fluorescent and incandescent lamps to combine intensity, diffusion and color effect in a desirable way. Spacing and power are such as to give an intensity of 25 ft.-candles in the assembly area and 30 ft.-candles at bench height in sub-assembly and machine shops. The entire plant is protected by sprinkler installation served from a 22-in. city water main (125-lb. pressure) and by a 150,000-gal. tank at ground level outside the plant, from which the supply to the sprinklers is maintained by an automatic pumping plant.

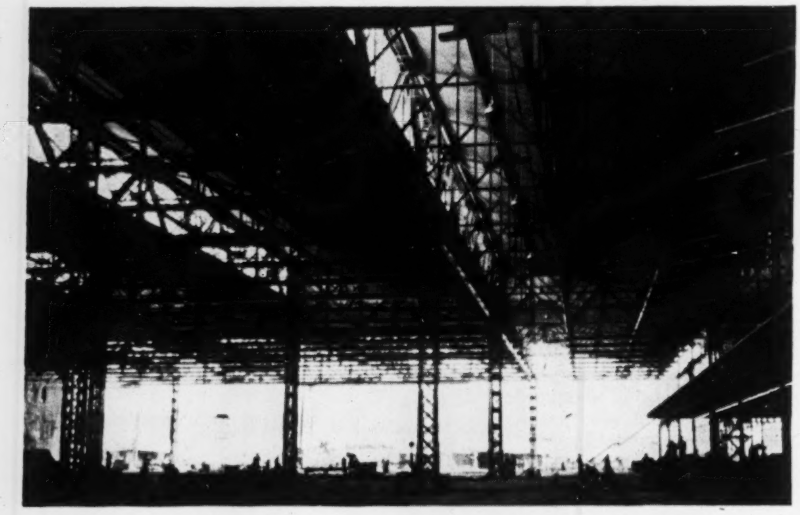


Fig. 7. Typical view across the roomy spaces of the assembly floor. A plane of almost 200-ft. wing spread could roll through the assembly areas.

Speed of construction

It was recognized at the outset that to complete this plant in 90 days would require unusual measures, the more so because a strike in Seattle had closed all structural steel shops but one. Accordingly, while foundation work was pushed along on a three-shift basis, contracts were allocated to some ten eastern plants for fabrication of the 2,300 tons of steel required. The heavier members, whose size precluded shipment, were fabricated at the one shop available locally. At every eastern mill and shop working on this contract a representative of the contractor made daily reports on progress and so expedited output that steel arrived on the job ten days ahead of the assembly schedule. Enthusiastic teamwork of the construction crews, which at the peak of operations included about 1,200 men, completed the job on schedule. Six subcontracts were let, namely piledriving, plumbing and heating, wiring, sprinkler system, sheet-metal and painting.

Personnel

The plant described is part of the properties of the Boeing Aircraft Co., Seattle, P. G. Johnson, president and general manager, H. O. West, assistant to the president in charge of manufacturing. It was designed and built by The Austin Co., W. J. Austin, president, W. R. Engstrom, district manager, and Richard Ellis, district engineer.

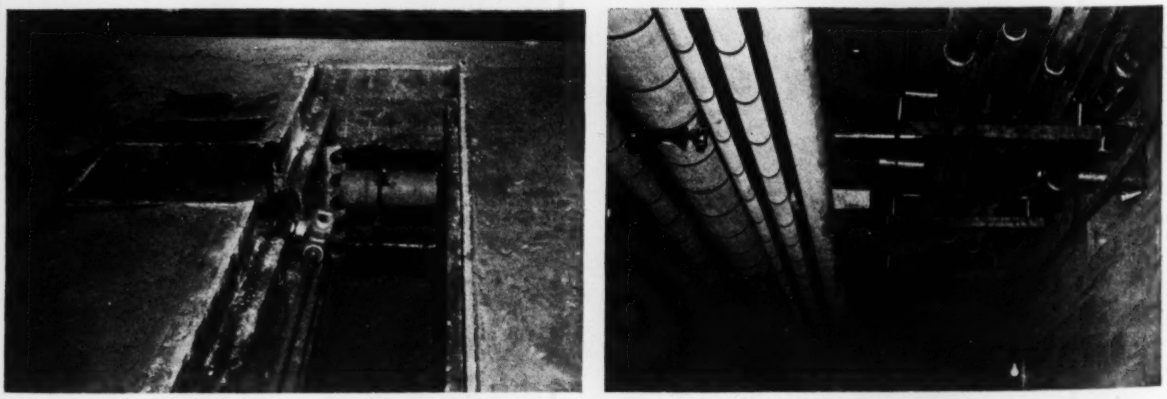


Fig. 8. All utilities are accessible in trenches in the floor which, as shown in the background of the left view, connect with the access tunnels in which, as shown in the view at the right, the main utility pipes and ducts are slung from the ceiling. Cold pipes are lagged to prevent condensate and attendant dripping.

Where We Stand on Roads for Defense

Contents in Brief—*Roads into and within military reservations and access roads to defense industry plants have first priority. Main links in the 75,000-mile strategic system are important but not of rush emergency character. Money available from PRA federal-aid funds, from WPA and from War and Navy Department allocations are insufficient without contributions by state and local governments.*

THE PRINCIPAL CHANGES in the defense road situation since it was outlined in great detail in the special defense road number of *Engineering News-Record*, Jan. 18, 1940, are to move up to emergency status those short pieces of highway needed to service military reservations and munitions plants and to give the Public Roads Administration authority to direct all federal-aid funds to defense highway purposes.

What is needed

Careful consideration of defense highway requirements has developed the necessity of the following program:

1. Improvements of roads serving as links in the 75,000-mile network of strategically important routes designated by the War Department.
2. Improvement of roads essential as accesses to army and navy reservations and mobilization points, to new and expanded defense industries and to airports and rail terminals and depots.
3. Improvements of roads and streets within military and naval reservations and the construction of the additional streets necessitated by the greatly enlarged forces to be stationed at many of the reservations.
4. Improvement or possible new construction of a very limited mileage of road required mainly for definite tactical purposes.

Access roads of first priority

Of these various classes of work those now most urgently required are the improvement of accesses to military and naval concentration points, the construction of roads and streets within the concentration areas, and the improvement of access to, and other essential road changes in the vicinity of, defense industrial plants and areas. The urgency of the first two types of improvements results from the current expansion of military posts to accommodate thousands of troops. The effect, from the standpoint of highways, is that of the sudden growth of many small village communities into cities of very substantial size and population.

On the industrial side of the defense preparation numerous new plants are being established, and these, especially where they are for the manufacture of explosives, are located on large tracts of land whose access road requirements will be materially beyond the facilities afforded by existing roads. In most cases, but especially in the case of explosives plants, the needs of access to the plants are complicated by the necessity of rerouting and reconstructing existing roads which in some cases are important main highways.

In addition to the entirely new plants required, the industrial mobilization, as it is thrown into high gear, is necessitating the great enlargement of established industries and plants of almost every conceivable sort in all parts of the country, with consequent heavily increased demands for highway service for the transportation of raw and finished products and also for the daily movement of employees to and from work.

Of similar character, but generally of a slightly lower priority in order of urgency, is the needed improvement of access to rail terminals and civil airports at many points throughout the country.

Strategic system is less pressing

The defense utilization of the designated country-wide strategic network presents problems which are considerably less pressing, but which are much broader in scope and decidedly more difficult and expensive of adequate solution. Except as portions of the network take on immediate importance as a result of proximity to military and naval reservations and sites of defense industries, or as improvements in certain areas are found to be needed to provide for early movements of the newly mechanized army forces, the planning and execution of improvements on the strategic network are matters requiring and permitting deliberate action in accordance with a long-time program.

Large bridge program certain

Most immediate of the improvement necessities on the network is the strengthening or reconstruction of some 1,800 out of approximately 16,000 bridges in rural areas which, as now designed, are inferior to the standard set by the H-15 loading specified by the American Association of State Highway Officials. To these weaker rural bridges should be added as a task of first importance the strengthening of a considerably smaller number of bridges on urban sections of the network to the A.A.S.H.O. H-20 standard as a minimum.

In rural areas the strategic routes of highest priority are substantially identical with the interregional routes proposed by the Public Roads Administration in its report to Congress entitled "Toll Roads and Free Roads", and the type of improvement eventually desirable for strategic purposes is no different from that required for the normal purposes of civil transportation.

Improvement objectives

On these and other rural sections of the strategic network the principal improvement needs are a greater directness of location between controlling points, alignment adjusted to the requirements of safe operation at modern vehicular speeds, surfaces and foundations capable of the year-round support of 9,000-lb. wheel loads on low-pressure tires, pavement widths adequate for present and expected traffic volumes, a substantial and general lengthening of sight distances, the separation of grades at intersections with both highways and railroads where the volume of traffic warrants, and the development of lateral protecting and beautifying marginal strips within rights-of-way of adequate width.

In urban and metropolitan areas the strategic highway needs are virtually identical with the requirements of civil traffic as defined in "Toll Roads and Free Roads", and require the same types of improvement—namely express roads with adequate terminal facilities associated with belt lines for distribution of the traffic between the radiating express facilities.

The special tactical roads required are few in number and small in mileage and, in comparison with other classes, are said to present few problems.

Funds that are available

For immediate improvements of roads of the several defense categories the only federal funds now available are:

1. Federal-aid highway funds (including funds for secondary or feeder roads and railroad grade crossing elimination) administered by the Public Roads Administration in cooperation with the state highway departments.
2. WPA funds.
3. Funds appropriated to the War or Navy Departments and allotted for expenditure on contracts let by the constructing quartermasters or public works officers of the various posts. These are available at present only for certain roads to be improved or constructed within the reservations.

The recently enacted federal-aid authorization act for the fiscal years 1942 and 1943 provides for expenditure of the authorized funds, *with or without state matching*, for the survey and planning of improvements on roads recommended as important to the national defense by any authorized defense agency. It also authorizes the Commissioner of Public Roads to give priority of approval to projects for the improvement of roads so recommended, *to be constructed with matched federal and state funds.*

The 1941 WPA appropriation act authorizes expenditure of not more than $25,000,000 of the appropriated funds to pay for supervision, equipment and materials in excess of the amounts normally expendable for these purposes on roads certified by the appropriate defense agency as strategically important.

The recommendation or certification of defense necessity required by these two acts as a basis for the preferential application of funds provided by them is furnished by the War and Navy Departments for improvements of accesses to military or naval reservations and for roads included in the strategic network. For the improvement of roads needed as accesses to defense industries the similar certification is given by the National Defense Advisory Commission.

Local financial aid necessary

Since all funds now available are together insufficient to meet the probable needs, serious delays of urgently needed improvements can only be avoided, it seems, by financial contributions by state and local governments. It is reported that determination of the detailed improvements needed and formation of financing schemes (in each instance utilizing all available federal and state or local funds) will be worked out by local conferences of all governmental and other agencies involved in accordance with arrangements now being perfected in Washington.

How Defense Housing Is Being Handled

***Contents in Brief**—Government funds totaling about $350,000,000 have been made available for defense housing. Some $250,000,000 of this amount will be spent by the Federal Works Agency, its Public Buildings Administration handling the bulk of the funds. John A. Carmody, FWA Administrator, outlines policy and procedure.*

IT IS ESTIMATED that between 160,000 and 200,000 new dwelling units will be needed to house families of enlisted personnel and of civilian employees of the armed services and to house both families and single employees in private industry engaged in defense production. At $3,500 per unit, the program could total as much as $700,000,000. Private industry, it is plain, must supply at least half of this investment, for total government defense housing money now adds up to about $350,000,000.

Briefly, the government funds come from a $100,000,000 appropriation in the second supplemental defense bill, allocated equally to the Army and Navy; from $150,000,000 appropriated to the Federal Works Agency in the Lanham Act; from $10,000,000 RFC equity money and $40,000,000 FHA mortgage money; and from USHA funds, of which $31,000,000 has so far been definitely allocated. Since considerably more than half of the defense housing money will be spent by the Federal Works Agency, John A. Carmody, FWA Administrator, was asked to outline the policy and procedure in so far as it had been determined. Mr. Carmody's statement follows:

Two phases of the defense housing program are being carried out by the Federal Works Agency—construction of the bulk of the housing provided for in the War Department's share of the 100 million dollar housing allocation in the Second Supplemental Defense Appropriation Act and construction of an undetermined number of dwelling units to be constructed with the 150 million dollar appropriation authorized in the Lanham Act.

Negotiated contracts to be used

The Secretary of War allocated $45,700,000 to the FWA a few days ago, directing this agency to carry out a list of housing projects for families of enlisted army men and for married civilian army personnel. There will be a minimum of 13,000 dwelling units in 70 projects, 19 of which are on sites owned by the Army. I have designated the Public Buildings Administration, a unit of FWA and for many years the principal builder of federal structures, as the agency to carry out this program. Contracts will be negotiated, using cost plus a fixed fee determined as a percentage of *estimated* cost.

In anticipation of this construction the PBA has had representatives in the field exploring site possibilities in localities where land must be acquired. In its Washington office, preliminary planning and design studies had been undertaken prior to the allocations.

While the statute establishes a maximum cost, it is our intention—and our confident expectation—that the maximum will not be reached by several hundred dollars. Our success in achieving low cost will depend a great deal on reasonable land and material costs. We intend to use every measure at our command to forestall any unwarranted jacking up of prices by those who would take advantage of the housing shortage and the need for speed. This program for the Army is scheduled for completion by May of next year. We expect to meet that schedule.

Housing Coordinator chooses projects

Designation of projects for construction of housing units under the Lanham Act will be made by the President, through the office of the Defense Housing Coordinator, C. F. Palmer. This act provides that the Federal Works Administrator may use any constituent agency of FWA, any other federal agency and any local public agency to carry out the $150 million program. The fixed-fee contract negotiation provision is included, and the average cost per dwelling unit shall not exceed $3,000, excluding land acquisition, public utilities and community facilities.

Plans for projects which will be constructed under the Lanham Act are not, at this writing, well enough formulated for detailed discussion. As an indication of the general approach, however, I can recite a few of the details about the projects which are to be built for the Army under the direction of the Public Buildings Administration.

Contractors selected for the Army housing projects will be chosen from those who have returned a special questionnaire recently circularized by the Public Buildings Administration. To initiate the file, all of the contractors known to the PBA, either through bid submissions or fulfilling contracts under the regular public buildings program, were forwarded the questionnaire when it was first issued. At the present time, approximately 1,500 builders in all parts of the country have declared themselves available for housing work, and new requests for the questionnaire are being received at a rate of 50 a day.

PBA will award contracts

As each new project is set up, a board composed of three members of PBA's Office of the Supervising Engineer will consult the questionnaires of those contractors who claim the project lies within their operating territory. Policy governing the award of contract is to give first consideration to construction firms in the area of the job. Some of the factors which the PBA will review are the contractor's present load, other government contracts currently held, organization, financial assets, and experience in the field of low-cost housing.

The contractor meeting all requirements will be recommended by the Public Buildings Commissioner to the Federal Works Administrator. Following FWA approval, he will be notified and requested to appear in Washington for further negotiations. On final approval by the Federal Works Administrator, award will be made by the Public Buildings Commissioner.

Every effort will be made to reduce the cost of the projects to keep them well below the maximum set by Congress. Plans are being studied for the possible mass purchase of fixtures and standard facilities such as bathtubs, toilet bowls, kitchen cabinets, ranges, refrigerators and heating units. If feasible, these facilities will be sought in a single standard size for all of the contemplated projects. PBA, through the Procurement Division, will place the orders and contractors will pay the vendor the fixed price, these costs to be reimbursed by the FWA in the contract payments.

Standardization of the housing units themselves will be aimed at lower costs. Designs now being prepared for the first projects will serve as pattern and precedent for the whole program. Three types already in the plan stage call for frame, masonry, and poured concrete construction. Study of a fourth type, prefabricated steel units, is now under way.

Fortunately the first projects to be chosen have already presented most of the design problems which must be met in the whole program. Plans are completed for single and duplex units, as well as multiple types to house up to eight families. The average family unit will consist of a living room, combined dinette-kitchen, two bedrooms and bath. There will be no basements. In general, PBA designers are following the FHA standards for low cost dwellings.

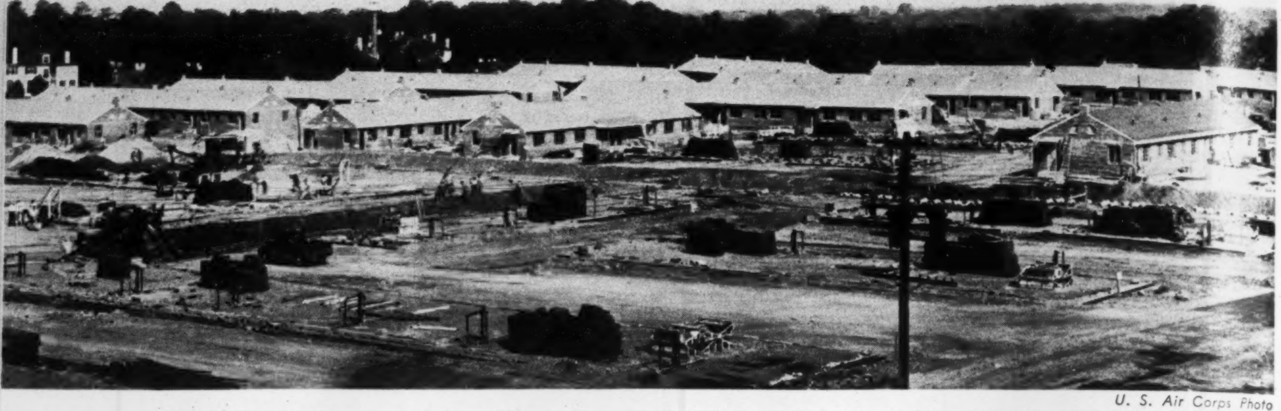
Whether the project is fifty units or five hundred units, it will merit a full set of community plans. In some instances the adjacent town will have its population doubled or tripled by the project residents, and site plans must include recreational and commercial areas. Arrangements of streets and parking areas will be in keeping with modern town planning. Schools, as well as other essential community facilities for future construction, will also be located on the plans. Public health standards as to drainage, sewage disposal and water supply will be met.

Water supply and sewerage will be extended to the project from the adjacent community whenever possible, though if this should not prove feasible, FWA plans will call for disposal plants and waterworks to be erected on the site. The Public Roads Administration, also in FWA, will be asked to consider the problems in its field to assure adequate transportation facilities.

No "emergency slums" to be created

In getting this program under way we have, of course, given much thought to the whole field of management problems that will be created. Every effort will be made to coordinate these undertakings with those of other federal agencies and with private enterprises through the Defense Housing Coordinator. We shall seek the cooperation and counsel of local housing authorities and local officials to the end that these projects will fit into community plans, and into the community social and economic life. Rentals for the houses occupied by enlisted personnel of the military branches will be fixed by those departments. Rentals for civilian defense workers will be fixed after taking into consideration all factors—quality of housing supplied, existing rent levels in the community, the family earning capacity of the occupants, and so on.

While this program is, as I write, but a few days old, I want to say that our whole staff is determined that the government will get its money's worth in good housing and that no "emergency slums" will be created.



U. S. Air Corps Photo

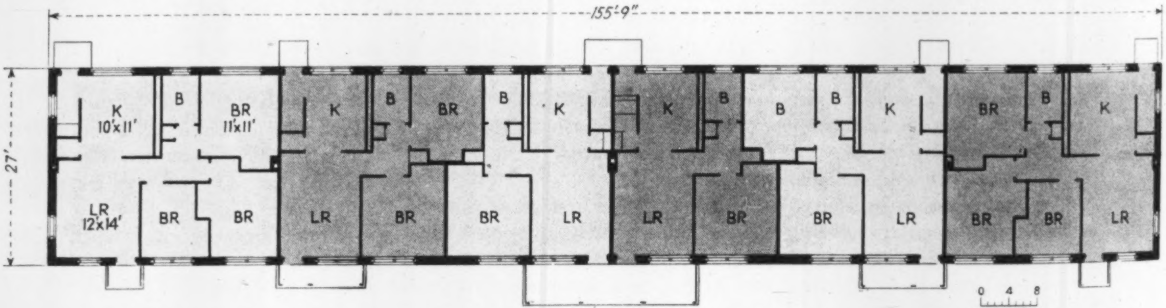
Fig. 1. Housing for army men working at Maxwell Field being built by the Housing Authority of Montgomery, Ala.

Defense Housing at Montgomery

***Contents in Brief**—Construction of housing to accommodate married men working in military reservations was authorized in June of this year and work on the first of these projects to be financed by the U. S. Housing Authority was begun at Montgomery, Ala., in August. This article relates chiefly to the Montgomery project, tells of its connection with other housing work there, the type of financing employed and methods of construction.*

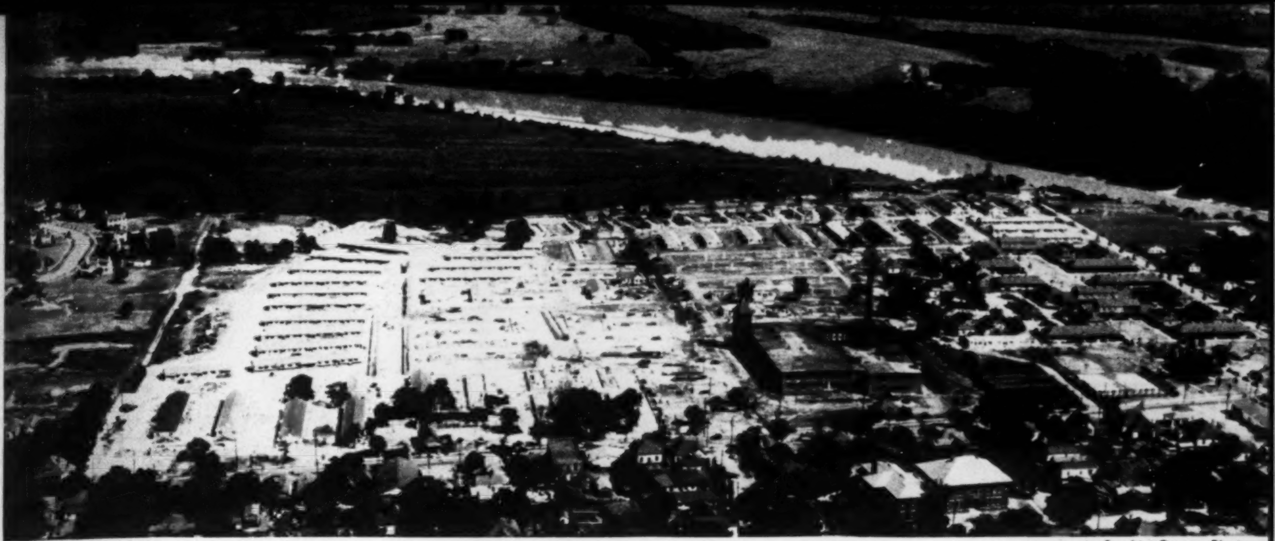
CONSTRUCTION OF HOUSING for married enlisted men and civilian employees working at expanded military establishments was recommended to Congress by the President early this year. The President proposed that this housing be built by the local housing authorities with financial aid from the U. S. Housing Authority and that it be located close enough to the city to permit it to be used as part of the city's normal housing when no longer needed for military personnel. Congress took no immediate action to provide funds for that purpose, but about the middle of June the USHA, by rescinding earmarkings of its funds for communities that had been unable to take them up, was able to make about $2,000,000 available for defense housing as proposed. Of this, $1,305,000 was allocated to the housing authority of Montgomery, Ala., for a housing project near the Army's airbase there, and $643,000 was allocated to the housing authority of Pensacola, Fla., for a project near one of the Navy's training centers at that point. Contracts for both projects were let soon thereafter. The one at Montgomery, the larger of the two, is described in the following. More recently similar work was authorized at Corpus Christi, Tex., and at Newport News, Va.

The Montgomery defense housing is located on the southern outskirts of the city close to the military reservation at Maxwell Field, which is the Southeast Air Corps Training Center of the Army. It consists of 85 buildings containing 424 dwelling units and adjoins the Riverside Heights housing development built by the PWA three years ago as a slum clearance project and now leased to the Housing Authority of the City of Montgomery. This year the local housing authority got funds from the USHA for another slum-clearance project of 137 dwelling units, which is being built as an extension of the original Riverside Heights development. The location of all three is shown in one of the accompanying airviews. Numerous old tenement



Floor Plan of the Six Dwelling Unit Building

Fig. 2. Floor layout of one of the six-dwelling-unit buildings. These units range from 3 to 5 rooms each. Shorter buildings, 27 x 94 ft., having two 4-room and two 3-room units, also are used for this project.



U. S. Air Corps Photo

Fig. 3. Three stages of housing development at Montgomery. At the right center is the city's first public housing project, Riverside Heights, built about three years ago. To the left of it, in the trees and in the square beyond the mill, new buildings for an extension of Riverside Heights are being built. In the left center and in the area beyond the old and new sections of the original housing project are the 85 buildings making up the defense housing project. Dwellings at the extreme left margin are in Maxwell Field, which indicates how close the project is to that field.

houses formerly occupied by cotton mill operatives have been torn down or soon will be. The abandoned cotton mill shown in the airview also is to come down, but at present it is being used to house troops from Maxwell Field.

No USHA subsidiary

The land for the Riverside Heights projects belongs to the local housing authority; the original buildings still are owned by the PWA and leased to the housing authority, and the new houses for the initial extension are being financed by the USHA on its regular loan and subsidy basis. There will be, however, no subsidy for the defense housing project so long as it is used for military purposes. This departure from the normal method of financing is made in the assumption that the soldiers and civilian employees will be able to pay sufficient rent to carry the project without subsidy. Rents will average around $20 per month including gas and electricity, gas being used for heating as well as cooking. The houses are equipped with hot-air heaters, ranges and refrigerators. The loan agreement provides for a return to the subsidy basis whenever the houses are taken over by families of low income. Rents charged the defense workers are expected to cover carrying charges and amortize the loan in 60 years.

A typical floor plan for one of the larger one-story buildings of the defense housing group is shown in Fig. 2. Each of the larger buildings contains two 5-room dwelling units, two 4-room and two 3-room units. The smaller buildings are of the same depth but are shorter and are used at points where space does not permit erection of the larger buildings. Quite similar structures are being put up in the adjoining slum clearance project except that the houses are to be two stories high.

Specifications called for foundations of concrete or of tile on concrete sills, for both the slum clearance project and the defense housing. Needing many bricklayers, the contractor for the latter elected to build tile foundations, while the contractor on the former work is building concrete foundations in order not to interfere with the defense project.

Substantial construction

Floors are of reinforced concrete, exterior walls are hollow tile faced with red brick, 10¼ in. thick, roof framing and deck are of treated timber covered with tar paper and surfaced with composition asbestos shingles. Flashing is of copper and the shelters over the doors are roofed with copper. The timber trusses for the roofs are framed in the contractor's shop and delivered to the site ready to be set in place.

All piping for water, gas and sewers is laid under the houses before the concrete floors are laid, risers being carried up above floor level. Interior partitions between dwelling units are of brick; other partitions are of solid plaster formed over expanded metal on steel supports. Interior finish is plaster. Sash and trim are steel and doors are wood.

Special care is taken in building the exterior walls to eliminate all trouble due to the passage of moisture through the wall. As shown in Fig. 4, the major part of the wall is made up of a tile of patented design that provides a large amount of air space and eliminates all continuous mortar joints through the wall. Headers from the brick facing are seated on isolated shoulders of the tile and the rear face of the brick is parged as a further check against the passage of moisture into the wall.

Brick chimneys with tile flues serve each dwelling unit.

Installation of sewers and water lines within the property lines is included in the contract for the work. Trenching machines were used for all major lines except where the main sewer outfall runs into a very deep cut near the edge of the bluff on which the housing is situated. Beyond the property line the local WPA will build the outfall sewer to the river. No sewage disposal is contemplated at present as sewage is discharged into the Alabama River into which the city also dumps its raw sewage.

Streets are to be surfaced with blacktop on a gravel base. About 20,000 sq.yd. will be required. Walks, curbs and gutters are to be of concrete.

Fast work required

A contract for construction of the project was let to Algernon Blair of Montgomery on July 31 at $1,113,-980, and the order to proceed was issued Aug. 5, time for completion being set at 120 calendar days. As of

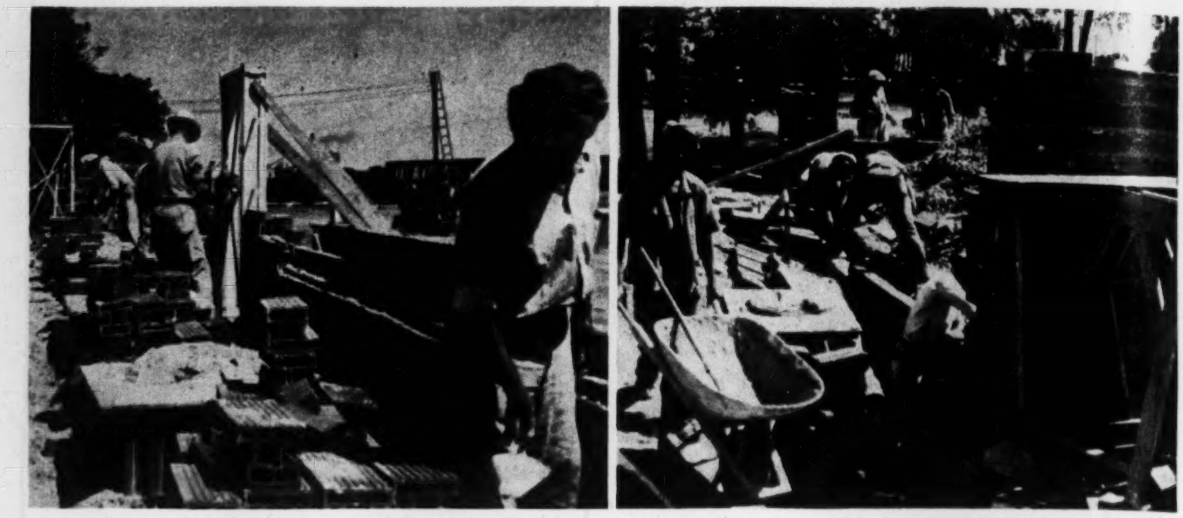


Fig. 4. Exterior walls are of brick and tile, as shown in the picture at left, 10¼ in. thick, the interior plaster being applied directly to the tile. The wall construction is designed to prevent the passage of moisture through the wall, there being no continuous mortar joints. At the floor level a water-proof membrane is laid on the end of the floor slab, which carries the tile, and down over the end of the slab and under the brick facing. The latter is supported directly on the foundation wall. The picture at the right shows a tile foundation wall under construction.

Sept. 28, 56 per cent of the work had been completed in eight weeks, leaving nine in which to complete the contract.

The contract includes demolition of old tenement houses, plumbing, gas space heaters, electrical work, and lighting fixtures, roads, walks, curbs and gutters, storm and sanitary sewers, electric distribution lines, water and gas mains and distribution, and fine grading of the site in preparation for placing topsoil. Grading will amount to 50,000 cu.yd.

Alternates authorized

With a view to giving the contractor opportunity for expediting delivery of materials, the specification gave a number of options: floor slabs could be poured on earthfill or on forms; steel sash for exterior windows were specified with an option for using wood frames and sash; interior door frames and trim were specified to be of metal bucks with an option for using wood; interior partitions could be either 3-in. hollow tile or 2-in. solid plaster; backup tile or brick could be used for backing. The contractor used metal windows and metal door bucks throughout, solid plaster partitions, hollow tile for backing, and earthfill for concrete floor slabs except one building where the natural grade made the use of forms more logical.

The floor slab is of reinforced concrete, supported at the outer edge on the foundation wall and strengthened near the center by a beam lengthwise of the building.

The buildings being all one-story made it practicable to carry each building to completion in less time than would have been required for two-story buildings; that is to say, it permitted the use of all trades at earlier dates than if the buildings had been two-story or more.

Work subdivided

The contractor set up the project on the basis of carrying on all buildings at the same time, dividing the project into three sections, A, B, and C, assigning a superintendent to each section, these being under the general superintendent. The three sections are progressing simultaneously, in a measure being operated as three contracts in entirely separate locations would be operated. There is an interchange of materials and men where occasion arises for this but each section has its separate aim for accuracy and speed. All clerical work, such as timekeeping, receiving, and distributing materials, is being handled in the contractor's central field office; each section has its field office, and there is installed a system of communication from each of these to the central office.

The scope of the work as thus planned permits the use of as many mechanics in the several trades as can be obtained or as can be used to reasonable advantage.

It was found to be unnecessary to work more than one shift, but frequently overtime is made where a particular situation makes it advisable. There is always some work to do on Saturdays and sometimes on Sundays in a very limited way, consisting mostly of preparation for the next week, but more particularly are the Saturdays valuable in catching up with deliveries of material.

The contractor's administrative force consists of thirty persons, general superintendent, superintendents, foremen, and clerical force. The average number of bricklayers is 100; of carpenters, 78; common labor for all trades runs from 400 to 600 men; the number of metal lathers averages 50, with a peak of 65; plasterers average 115; plumbers and gasfitters, as many as 40, and an average of 30; roofing mechanics, 18; electricians, 18; glaziers, 12; ironworkers, principally erection of steel windows, 10; painters, 45 to 50. Sidewalks, gutters, and curbs require an average of 16 cement finishers with their helpers. The total number of men on all the work runs generally about 950.

Supervision

Charles P. Rogers is executive director of the Housing Authority of the City of Montgomery and John C. Humphrey is construction advisor representing the U. S. Housing Authority. Moreland G. Smith, Montgomery, is architect. The contractor, as noted previously, is Algernon Blair of Montgomery.